

## 2.5L 4-CYL - VIN [P]

### 1993 Jeep Cherokee

1993 CHRYSLER CORP. ENGINES  
2.5L 4-Cylinder

Jeep: Cherokee, Wrangler

### ENGINE IDENTIFICATION

**NOTE:** For engine repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article in the GENERAL INFORMATION section.

Engine can be identified by eighth character of Vehicle Identification Number (VIN). The VIN is stamped on a plate attached to top left corner of instrument panel.

Engine code is on a machined surface on right side of cylinder block between cylinders No. 3 and 4. This code may be required when ordering replacement parts.

#### ENGINE IDENTIFICATION CODES TABLE

Application	VIN Code
2.5L 4-Cylinder PFI .....	P

Some engines are manufactured with oversize or undersize components. These engines are identified by a letter code stamped on oil filter boss near distributor. Letters are decoded as follows:

- \* "B" indicates all cylinder bores .010" (.25 mm) oversize.
- \* "C" indicates all camshaft bearing bores .010" (.25 mm) oversize.
- \* "M" indicates all main bearing journals .010" (.25 mm) undersize.
- \* "P" indicates one or more connecting rod journals .010" (.25 mm) undersize.
- \* "PM" indicates all crankshaft main bearing journals and one or more connecting rod journals .010" (.25 mm) undersize.

### ADJUSTMENTS

#### VALVE CLEARANCE ADJUSTMENT

Engine is equipped with hydraulic valve lifters. No valve adjustment is required.

### REMOVAL & INSTALLATION

**NOTE:** For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

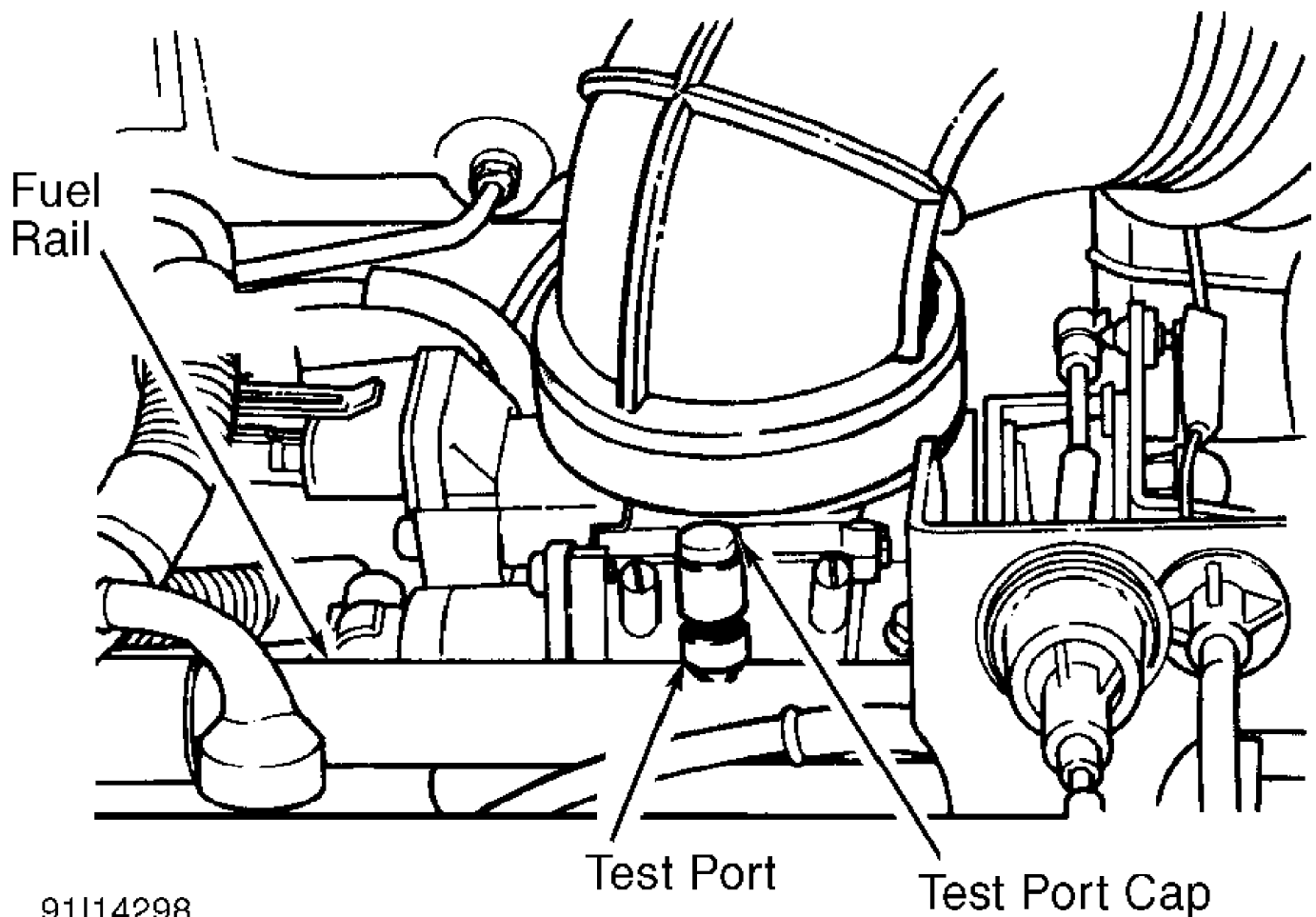
**CAUTION:** When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

## FUEL PRESSURE RELEASE

**CAUTION:** Fuel system is under constant pressure. This pressure must be released before disconnecting or servicing any fuel supply or return system component. Wear proper eye protection when releasing fuel system pressure.

Disconnect negative battery cable. Remove fuel filler cap. Remove cap from pressure test port on fuel rail. See Fig. 1. Place shop towels around pressure test port to absorb spilled fuel. Press test port valve with a small screwdriver or punch wrapped in shop towels. Remove shop towels and dispose of properly. Install pressure test port cap.

**CAUTION:** Always replace "O" rings, spacers and retainers whenever fuel system quick-connect fittings are disconnected. Ensure fuel connections are secure by verifying that only retainer tabs protrude from connectors, and by pulling on tubes to verify that they are secure.



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Fig. 1: Locating Fuel Pressure Bleeding Test Port  
Courtesy of Chrysler Corp.

## COOLING SYSTEM BLEEDING

**CAUTION:** Engine coolant may be hot. To avoid scalding, carefully

release system pressure before removing radiator cap or drain cock.

Fill radiator completely and install pressure cap. Fill reserve/overflow tank to FULL mark. Operate engine until it reaches normal operating temperature. Shut off engine and allow it to cool. Recheck coolant level in reserve/overflow tank as necessary. Add coolant ONLY when engine is cold.

## ENGINE

### Removal (Cherokee)

1) Remove battery and air cleaner. Remove hood. Drain cooling system. Remove radiator hoses, coolant recovery hose and fan shroud. Disconnect transmission fluid cooler lines (if equipped).

2) Discharge A/C system (if equipped). Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove A/C condenser (if equipped) and radiator. Remove fan. To maintain pulley and water pump alignment, install a 5/16 x 1/2" bolt through fan pulley into water pump flange.

3) Disconnect heater hoses, throttle linkage, cruise control cable (if equipped) and throttle valve rod. Disconnect wires from starter solenoid, oxygen (O2) sensor and all fuel injection harness connections.

4) Release fuel pressure. See FUEL PRESSURE RELEASE. Disconnect fuel supply and return lines at fuel rail. Disconnect TDC sensor wire connector. Remove A/C service valves and cap compressor ports (if equipped).

5) Remove vacuum check valve from power brake booster (if equipped). Disconnect power steering hoses at steering gear (if equipped). Drain power steering pump reservoir. Cap power steering hoses and fittings.

6) Tag and disconnect any remaining hoses or electrical connectors. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Remove starter and flywheel cover.

7) On automatic transmission equipped models, mark converter and flexplate for installation reference. Remove converter-to-flexplate bolts. On all models, remove upper bellhousing bolts and loosen bottom bolts. Remove engine mount bolts.

8) Remove engine shock damper bracket. Lower vehicle. Attach lifting device to engine. Raise engine from front supports. Place support under bellhousing. Remove remaining bellhousing bolts. Remove engine.

### Removal (Wrangler)

1) Pad windshield with cloth. Raise hood and rest it against windshield frame. Drain cooling system. Remove battery. Disconnect wiring from alternator, ignition coil, distributor, oil pressure sender and fuel injection wire harness.

2) Disconnect fuel line quick-connect couplings at fuel rail. Remove engine ground strap. Remove air cleaner. Disconnect vacuum purge hose from vapor canister tee. Unplug idle speed actuator connector. Disconnect throttle cable and remove it from bracket.

3) Disconnect throttle rod at bellcrank. Unplug oxygen (O2) sensor connector. Disconnect coolant hoses at radiator, intake manifold and thermostat housing. Remove fan shroud and radiator. Remove fan and spacer. Install a 5/16 x 1/2" bolt through fan pulley into water pump flange to maintain pulley and water pump alignment.

4) Remove check valve from power brake booster (if equipped). Disconnect power steering hoses at steering gear (if equipped). Drain power steering pump reservoir. Cap power steering hoses and fittings.

5) Tag and disconnect any remaining hoses or electrical connectors. Raise and support vehicle. Disconnect exhaust pipe from

exhaust manifold. Remove starter. Remove flywheel housing access cover. Remove engine mount through-bolts. Remove upper bellhousing bolts. Loosen lower bellhousing bolts.

6) Lower vehicle. Attach lifting device to engine. Raise engine from front supports. Place support under bellhousing. Remove remaining bellhousing bolts. Lift engine from engine compartment.

#### Installation (All Models)

Remove engine mount cushions from brackets to aid alignment of engine and transmission. To complete installation, reverse removal procedure. Adjust throttle and cruise control linkage (if equipped). Tighten bolts to specification. See TORQUE SPECIFICATIONS table. Refill and check fluid levels.

### INTAKE MANIFOLD

#### Removal

1) Disconnect negative battery cable. Remove air inlet hose at throttle body and air cleaner. Remove power steering pump with hoses attached and wire it aside.

2) Release fuel pressure. See FUEL PRESSURE RELEASE. Remove power steering pump brackets at water pump and intake manifold. Disconnect fuel supply and return lines at fuel rail.

3) Disconnect accelerator cable. Unplug cruise control connector at throttle body, using finger pressure only. Remove crankcase ventilation and manifold pressure sensor hoses. Tag and disconnect all wiring and hoses.

4) Remove bolts No. 2 through 5 securing intake manifold to cylinder head. See Fig. 2. Slightly loosen bolt No. 1 and nuts No. 6 and 7. Remove intake manifold. Drain coolant from manifold.

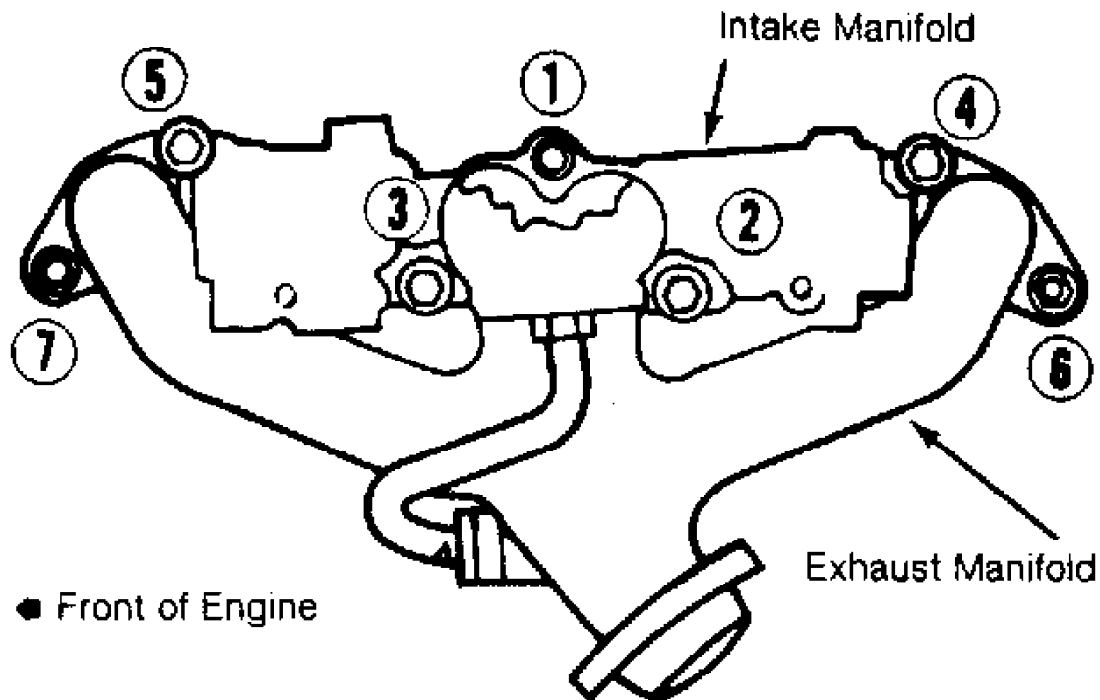


Fig. 2: Intake & Exhaust Manifold Bolt Tightening Sequence  
Courtesy of Chrysler Corp.

#### Installation

Ensure all gasket surfaces are clean. Install intake



manifold. Finger tighten all bolts. Tighten intake manifold bolts to specification in correct sequence. See Fig. 2. Also see TORQUE SPECIFICATIONS table. To complete installation, reverse removal procedure. Fill and bleed cooling system.

## EXHAUST MANIFOLD

### Removal

Disconnect negative battery cable. Remove intake manifold. See INTAKE MANIFOLD. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Lower vehicle. Remove retaining nuts and bolts. Remove exhaust manifold.

### Installation

1) Clean all gasket surfaces. Install intake and exhaust manifolds together, using NEW gasket. Ensure exhaust manifold is centrally located over end studs and spacer. Tighten bolt No. 1 to specification. See TORQUE SPECIFICATIONS table. Tighten bolts No. 2 through 5 to specification in sequence. See Fig. 2.

2) Install new spacers over cylinder head studs. Tighten nuts No. 6 and 7 to specification. To complete installation, reverse removal procedure. Start engine and check for leaks.

## CYLINDER HEAD

### Removal

1) Disconnect negative battery cable. Drain cooling system. Remove accessory drive belt. Remove A/C compressor (if equipped) and wire it aside. DO NOT discharge A/C system. Remove air cleaner.

2) Remove A/C compressor mounting bracket-to-cylinder head bolts. Loosen A/C compressor mounting bracket-to-cylinder block bolts. Disconnect upper radiator hose and heater hoses. Remove valve cover.

3) Remove rocker arms, bridges, pivots and push rods. Tag all parts for installation reference. See ROCKER ARMS. Remove manifolds. See INTAKE MANIFOLD and EXHAUST MANIFOLD.

4) Tag and disconnect spark plug wires. Remove spark plugs. Remove cylinder head bolts. Remove cylinder head. Stuff clean lint-free shop towels into cylinder bores.

### Inspection

1) Inspect cylinder head for cracks or damage. Using straightedge, check cylinder head for warpage across bolt holes and diagonals. Resurface or replace cylinder head if warpage exceeds specification or damage exists. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

2) Cylinder head bolts may be REUSED ONLY ONCE. If this is the first time cylinder head has been removed, put a dab of paint on the head of each bolt. If the bolts already have paint on them, or if it is unknown whether they have been used before, DISCARD THEM and replace with NEW bolts.

### Installation

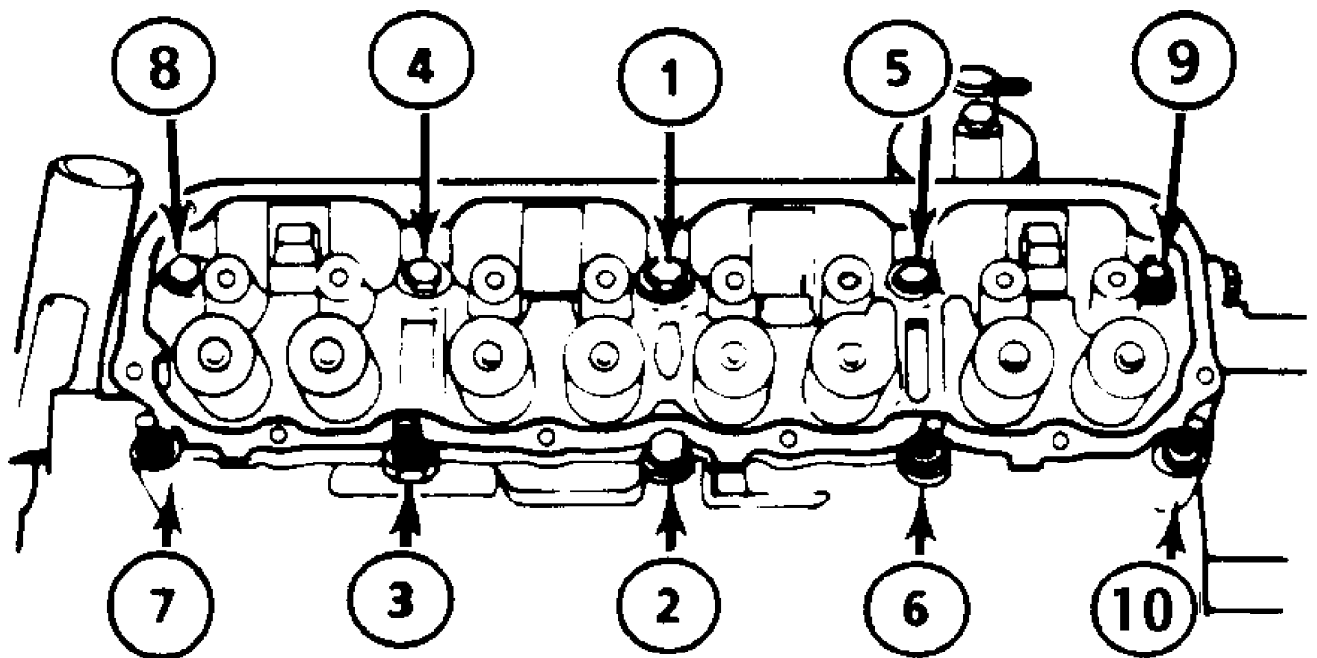
1) Clean carbon from combustion chambers and tops of pistons. Ensure all gasket surfaces, head bolts and head bolt holes are clean. Install NEW cylinder head gasket with numbers or word TOP upward. DO NOT apply sealant to cylinder head gasket. Ensure all holes align properly.

2) Install cylinder head. Apply sealing compound to threads of cylinder head bolt No. 7 before installation. Install cylinder head bolts. Tighten all bolts in 3 stages in sequence to specs. See Fig. 3. For torque specifications see TORQUE SPECIFICATIONS table.

NOTE: During the final tightening sequence, bolt No. 7 will be

tightened to a lower torque than the others.

3) To complete installation, reverse removal procedure. Install all valve train components into their original locations. Refill cooling system. Remove coolant temperature sensor to bleed air from system while filling.



### ◆ FRONT OF ENGINE

**50H02187**

Fig. 3: Cylinder Head Bolt Tightening Sequence  
Courtesy of Chrysler Corp.

### FRONT COVER OIL SEAL

#### Removal & Installation

1) Remove drive belt. Remove vibration damper. Remove radiator shroud. Remove seal from front cover. Apply sealant to outer diameter of new seal. Coat crankshaft lightly with oil.

2) Drive seal into front cover, using Front Cover Aligner/Seal Installer (6139). Lightly coat seal contact area of vibration damper with oil. Lubricate vibration damper bolt with oil before installation. Reverse removal procedure to complete installation. See TORQUE SPECIFICATIONS table.

### TIMING CHAIN & SPROCKETS

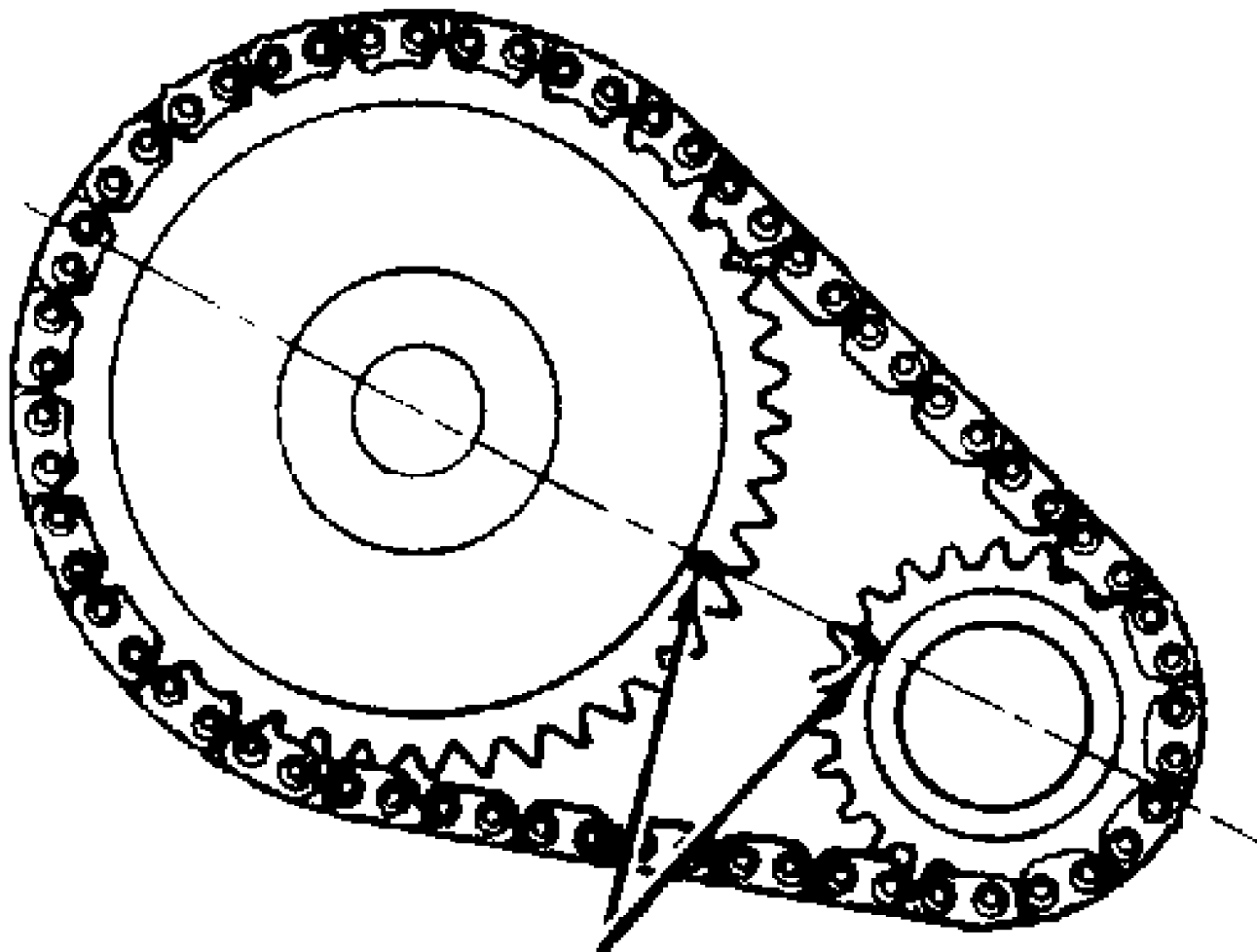
#### Removal

1) Disconnect negative battery cable. Remove drive belt, fan and hub assembly. Remove fan shroud. Remove accessory drive brackets attached to timing case cover. Remove A/C compressor (if equipped) with hoses attached and wire it aside. DO NOT discharge A/C system. Remove alternator bracket assembly from cylinder head.

2) Remove vibration damper retaining bolt and washer. Remove vibration damper and key. Remove front cover retaining bolts and front cover. Cut oil pan gasket flush with face of cylinder block. Remove cut-off pieces.

3) Rotate crankshaft until timing marks on crankshaft and camshaft sprockets align. See Fig. 4. Remove oil slinger and camshaft

sprocket retaining bolt. Remove sprockets and chain as an assembly.  
Remove front cover oil seal.



## Timing Marks

Fig. 4: Aligning Sprocket Timing Marks  
Courtesy of Chrysler Corp.

### Installation

1) Turn tensioner lever down to unlock position. Pull tensioner block toward lever to compress spring. Turn lever up to lock position. See Fig. 5. Install timing chain and sprockets as an assembly. Ensure timing marks align. Install camshaft sprocket retaining bolt and washer. Tighten to specification. See the TORQUE SPECIFICATIONS table.

NOTE: Ensure chain tensioner is in unlock (down) position before installing front cover.

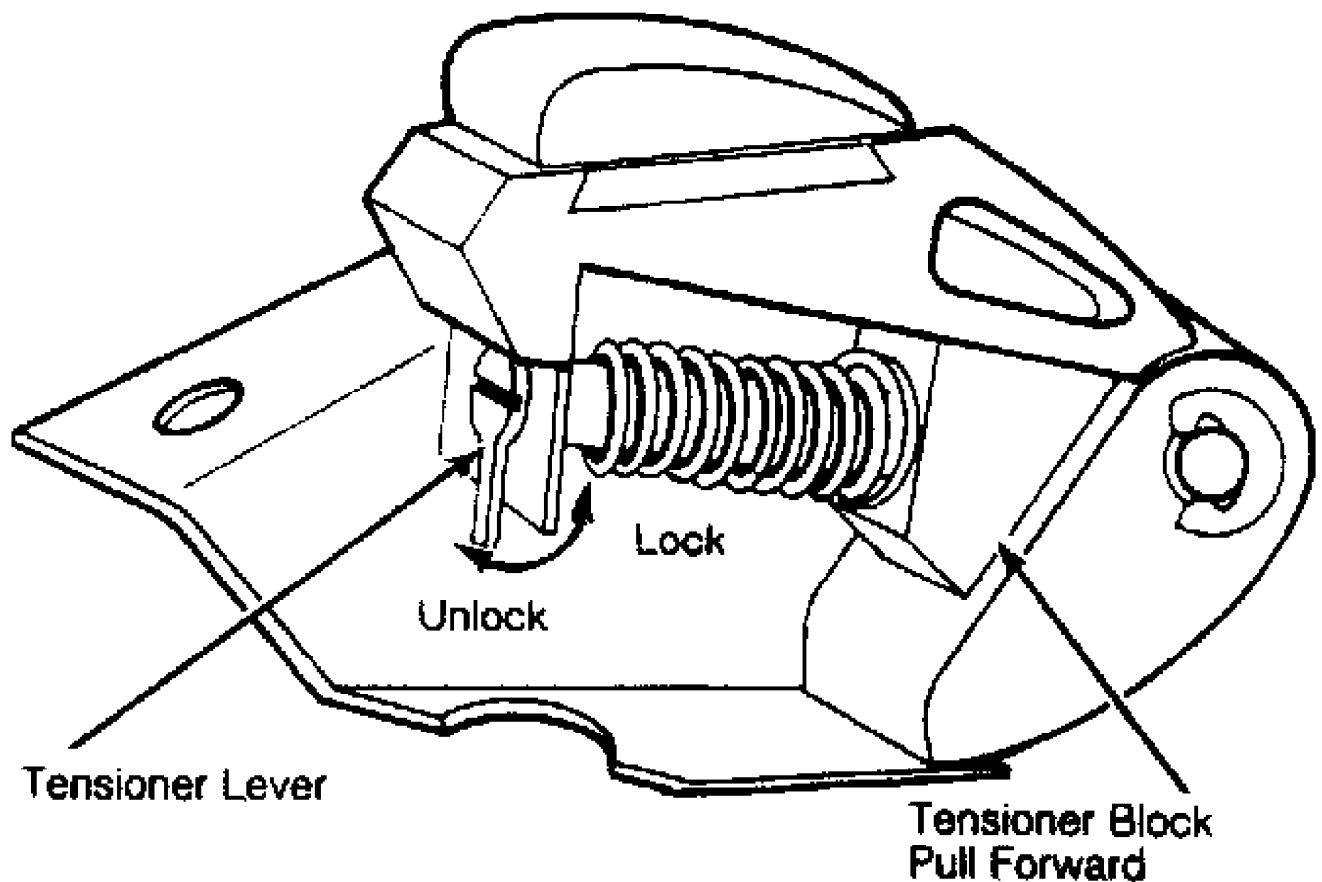


Fig. 5: Locating Chain Tensioner Lock  
Courtesy of Chrysler Corp.

2) Verify proper installation by rotating crankshaft until timing mark on camshaft is at approximately one o'clock position. Timing sprockets are installed correctly if there are 20 timing chain pins between timing marks on both sprockets.

3) Clean all gasket surfaces. Install oil slinger. Apply sealing compound to both sides of front cover gasket. Install gasket onto cylinder block. Replace front section of oil pan seal with similar piece cut from new seal.

4) Coat outer surface of NEW seal with RTV sealant and place into position. Apply sealant where oil pan and cylinder block meet. Place front cover onto cylinder block. Place Front Cover Aligner/Seal Installer (6139) in front engine cover seal area.

5) Install cover retaining bolts, and tighten to specification. To complete installation, reverse removal procedure. Lubricate vibration damper retaining bolt before installation, and tighten to specification. See TORQUE SPECIFICATIONS table.

## ROCKER ARMS

### Removal

Remove valve cover. Alternately loosen rocker arm cap screws one turn at a time to prevent damaging bridges. Remove bridges, pivots, rocker arms and push rods. Tag all parts for reassembly reference.

#### Installation

1) Lubricate push rod ends with Mopar Engine Oil Supplement (4318002). Install push rods into their original locations. Ensure bottom end of each push rod is centered in valve lifter.

2) Lubricate pivot contact area of each rocker arm with engine oil supplement. Install rocker arms, pivots and bridges into their original locations. Loosely install cap screws, then tighten alternately one turn at a time to specification. Reverse removal procedure to complete installation.

3) Pour remaining engine oil supplement over entire valve train. Supplement must remain in engine oil for at least 1000 miles (1600 km), but need not be drained until next scheduled oil change.

### CAMSHAFT

#### Removal

1) Disconnect negative battery cable. Drain cooling system. Discharge A/C system (if equipped), using approved refrigerant recovery/recycling equipment. Remove A/C condenser (if equipped) and radiator. Mark distributor and engine block for installation reference. Remove distributor and ignition wiring. Remove rocker arms, bridges, pivots and push rods. See ROCKER ARMS.

2) Remove valve lifters using Hydraulic Valve Lifter Remover/Installer (C-4129-A). Tag each valve lifter for installation reference. Remove timing chain and sprockets. See TIMING CHAIN & SPROCKETS. Remove camshaft.

#### Inspection

Inspect lobes, journals, bearings and distributor drive gear for wear. If camshaft sprocket or chain rubs against engine front cover, examine oil pressure relief holes in rear camshaft journal. Oil pressure relief holes MUST be free of debris.

#### Installation

1) Lubricate camshaft and dip valve lifters into Mopar Engine Oil Supplement (4318002). Install camshaft. Reverse removal procedure to complete installation.

2) Pour remaining oil supplement over entire valve train. Supplement must remain in engine oil for at least 1000 miles (1600 km), but need not be drained until next scheduled oil change. Refill cooling system. Adjust ignition timing. Check for leaks.

### REAR CRANKSHAFT OIL SEAL

#### Removal

Remove transmission, clutch housing and flywheel or flexplate. Pry oil seal from housing. Avoid damage to surrounding area.

#### Installation

Coat outer lip of replacement seal with engine oil. Using Installer (6271), install seal flush with cylinder block. Use only NEW bolts when installing flywheel or flexplate. Ensure felt lip is inside flywheel mounting surface to avoid tearing seal. To complete installation, reverse removal procedure. Tighten flywheel or flexplate bolts to specification, then an additional 60 degrees. See the TORQUE SPECIFICATIONS table.

### WATER PUMP

#### Removal

Disconnect negative battery cable. Drain cooling system. Remove fan shroud and drive belts. Remove fan assembly. Disconnect

heater hoses and lower radiator hose at water pump. Remove water pump retaining bolts. Remove water pump.

#### Installation

Install water pump. Tighten bolts to specification. See TORQUE SPECIFICATIONS table. Ensure pump turns freely. Ensure belt is installed correctly to prevent engine overheating because water pump rotates in wrong direction. To complete installation, reverse removal procedure. Fill and purge air from cooling system. Remove coolant temperature sensor to bleed air from system while filling.

## OIL PAN

#### Removal

1) Disconnect negative battery cable. Raise and support vehicle at side sills. Drain engine oil. Disconnect exhaust pipe at exhaust manifold. Disconnect exhaust hanger at catalytic converter. Lower exhaust pipe. Remove starter. Remove flywheel access cover.

2) Position jackstand directly under vibration damper. Place wooden block between vibration damper and jackstand. Remove through bolts from engine mounts. Raise engine enough to remove oil pan. Remove oil pan retaining bolts. Remove oil pan by sliding it to rear.

#### Installation

1) Ensure all gasket surfaces are clean. Fabricate 4 alignment dowels from 1 1/2 x 1/4" bolts. Cut heads off bolts and cut slot in end of bolts to allow removal with screwdriver. Install 2 dowels in timing cover and 2 dowels in block. Slide gasket over dowels into position against block and timing cover.

2) Install oil pan. Install sufficient bolts to hold oil pan in place. Remove alignment dowels. Install remaining oil pan bolts and tighten to specification. See TORQUE SPECIFICATIONS table. To complete installation, reverse removal procedure. Fill crankcase. Start engine. Check for leaks.

## OVERHAUL

### CYLINDER HEAD

#### Inspection

Inspect for cracks in combustion chambers, coolant passages, ports and exhaust valve seats. Using straightedge, check cylinder head for warpage in several areas. Repair or replace cylinder head if warpage exceeds specification or damage exists. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valve Springs

Use Valve Spring Tester (J-22738-02) to test each valve spring. Measure free length of each valve spring. Replace valve springs that do not meet specifications. See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS.

#### Valve Stem Oil Seals

Replace valve stem oil seals if they have deteriorated or whenever valves are serviced. Oil seals are marked INT and EXH for intake and exhaust valves, respectively. Oversize oil seals must be used with valves having .015" (.38 mm) oversize stems.

#### Valve Guides

Measure diameter of valve guide approximately 3/8" (10 mm) from valve spring side of head, both parallel and at right angle to long axis of head. If difference between measurements exceeds .0025"

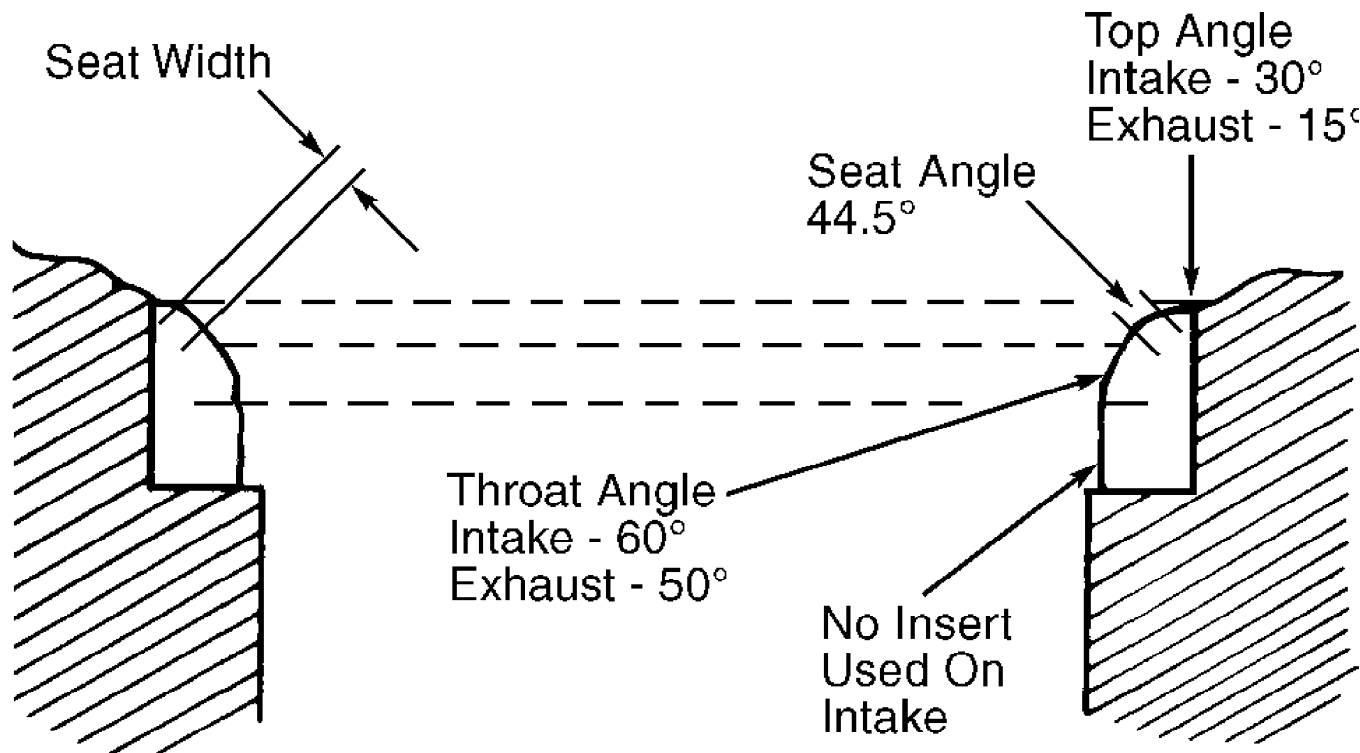
(.063 mm), or if diameter exceeds specification by .003" (.08 mm), ream valve guide for oversize valve stem. See CYLINDER HEAD table under ENGINE SPECIFICATIONS. Reface valve seats after reaming valve guides.

#### Valve Seats

Reface valve seats to specification. Remove only enough metal to provide smooth finish. Use tapered stones to obtain specified seat width. See Fig. 6. Seat width runout should not exceed .0025" (.063 mm) after refacing. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valves

Reface valves to specification. At least 1/32" (.79 mm) margin must remain after refacing valve. Valve stem tip can be resurfaced and chamfered when worn. DO NOT remove more than .01" (.25 mm). See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS.



91C14300

Fig. 6: Checking Valve Seat Dimensions  
Courtesy of Chrysler Corp.

## VALVE TRAIN

### Rocker Arms

Inspect pivot and valve stem contact surfaces of each rocker arm. Replace any rocker arm that is scuffed, pitted, cracked or excessively worn.

### Push Rods

Inspect push rods for excessive wear. If wear is excessive because of lack of oil, replace and inspect corresponding valve lifter for excessive wear. Roll push rods on a flat surface to check for straightness. Replace push rod and/or valve lifter, if necessary. If

wear exists along length of push rod, inspect cylinder head for obstruction.

## CYLINDER BLOCK ASSEMBLY

### Piston & Rod Assembly

1) Note locations of arrow on piston crown and oil squirt hole in connecting rod. Position piston and rod assembly on support. See Fig. 7. Press piston pin from piston. Discard pin. Piston pin CANNOT be reused after removal. Inspect piston pin bore in connecting rod for nicks or burrs and remove as necessary.

2) Clean piston pin bore and replacement piston pin. Piston and piston pin must be at room temperature when measuring fit. Piston pin should fall through piston at room temperature. If pin jams in pin bore, replace piston.

3) Position piston on support so that arrow on piston crown will point to front of engine and connecting squirt hole will face camshaft when installed. Insert piston pin through piston pin bore and into connecting rod pin bore.

4) Press pin through rod and piston until pilot aligns with mark on support. Pin should be centered in rod. Piston pin installation requires approximately 2000 lbs. (900 kg) of force. Replace connecting rod if noticeably less force is required, or if rod moves on pin.

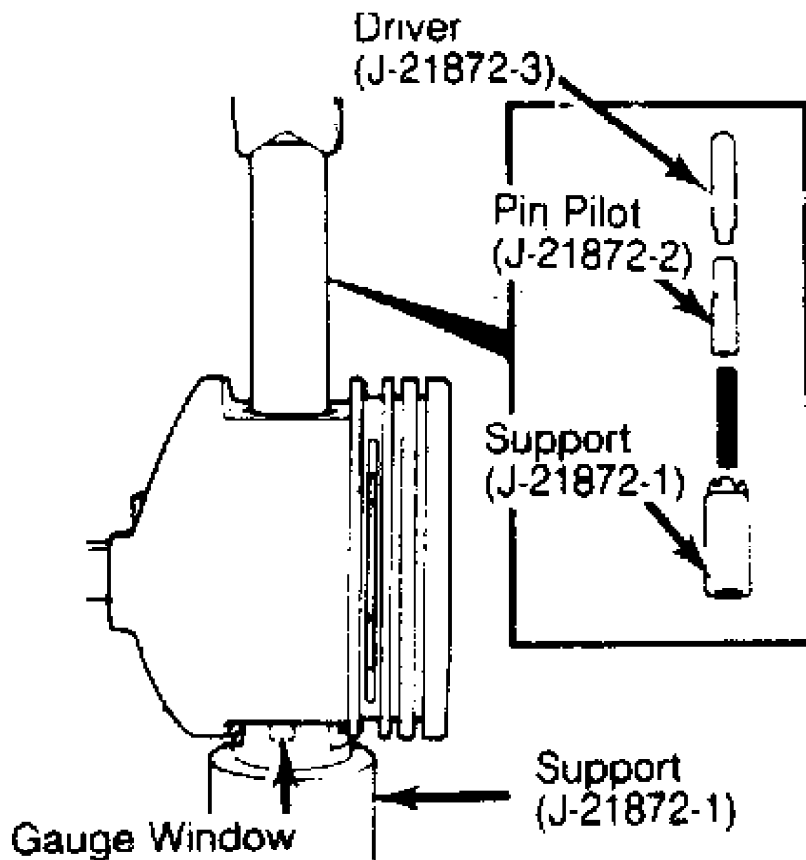


Fig. 7: Removing & Installing Piston Pin  
Courtesy of Chrysler Corp.

### Fitting Pistons

Measure cylinder bore 2 5/16" (59 mm) below top of bore.



Measure piston diameter at right angle to piston pin at center line of pin. Piston clearance is difference between measurements. Pistons up to .004" (.10 mm) undersize may be enlarged by knurling or shot peening. Replace pistons if clearance is greater than .004" (.10 mm) or more.

#### Piston Rings

Install piston rings. DO NOT interchange piston rings. Top ring has a Gray scraping surface; second ring is Black. Ensure ring end gap and side clearance are within specifications. Install compression rings with dot(s) on ring surface toward top of piston. Position ring end gaps in specified area. Ring gaps may vary 20 degrees from locations illustrated. See Fig. 8. Also see PISTONS, PINS & RINGS table under ENGINE SPECIFICATIONS.

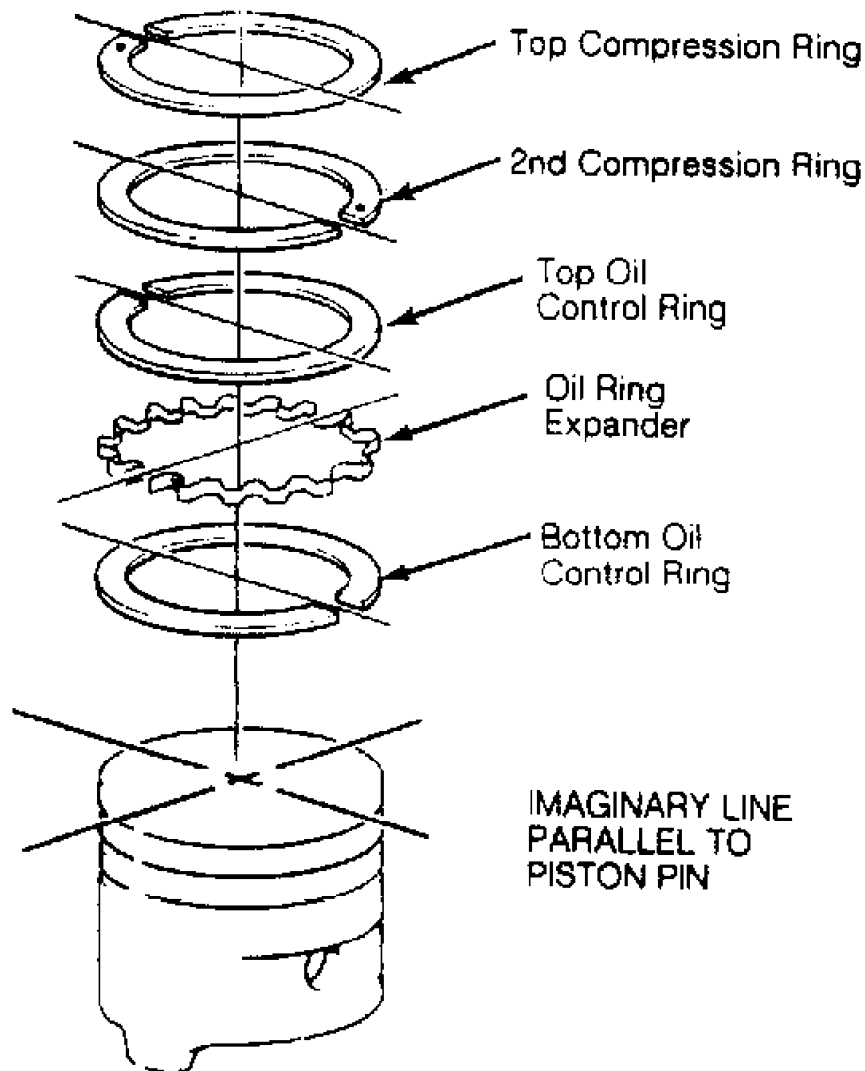


Fig. 8: Positioning Piston Ring Gaps  
Courtesy of Chrysler Corp.

#### Rod Bearings

- 1) Inspect bearings for wear or damage. Replace as necessary.

Using Plastigage, check bearing clearance. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS. Bearings are available for standard and undersize applications.

2) If necessary, different size upper and lower bearings may be combined to obtain correct oil clearance. Tighten bolts to specification. Check rod side play. Rotate crankshaft to ensure freedom of movement. See TORQUE SPECIFICATIONS table. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table.

NOTE: Never combine bearing inserts that differ by more than .001" (.03 mm) in size. Odd size inserts must be on bottom (rod cap) side.

#### Crankshaft & Main Bearings

1) Inspect bearings for damage or wear. Replace as necessary. Using Plastigage, measure bearing clearance. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS. Bearings are available in standard and undersize. If necessary, different size upper and lower bearings may be installed to obtain correct oil clearance. Lubricate bearings before installation.

NOTE: If different size bearings are installed, the odd size bearings must all be uniform in location (upper or lower). Never combine bearing inserts that differ by more than .001" (.03 mm).

2) Install upper bearing inserts. Install bearing caps and lower inserts. Tighten bearing caps No. 1, 3, 4 and 5 in 3 stages to specification. Pry crankshaft to front or rear and tighten bolts for cap No. 2 to specification in 3 stages. Rotate crankshaft to ensure freedom of movement after tightening each cap. See the TORQUE SPECIFICATIONS table. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table.

#### Thrust Bearing

Check crankshaft end play. If end play is not within specification, replace bearing No. 2. If end play is still not within specification, replace crankshaft. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS.

#### Cylinder Block

1) Measure cylinder bore diameter crosswise to cylinder block near top of bore. Repeat measurement at bottom of bore. Subtract smaller diameter from larger diameter to determine taper. Repeat measurements for each cylinder.

2) Repeat measurements with measuring device rotated 120 degrees. Repeat this step for a total of 3 measurements. Cylinder out-of-round is the difference between measurements. Repeat for each cylinder.

3) Bore and hone cylinders for oversize pistons if taper or out-of-round exceeds specification. Move hone up and down to provide a 60-degree crosshatch pattern. DO NOT use a rigid hone or exceed 10 strokes per cylinder. See CYLINDER BLOCK table under ENGINE SPECIFICATIONS.

## LUBRICATION

### ENGINE OILING

A distributor-driven pump supplies oil through a full-flow oil filter to an oil gallery on right side of block and intersecting lifter bores. Oil then flows to camshaft and crankshaft bearings. The

rocker arms receive oil through the push rods and lifters.

#### Crankcase Capacity

Crankcase capacity is 4 qts. (3.8L) with oil filter change.

#### Oil Pressure

Normal oil pressure should be 25–35 psi (1.8–2.5 kg/cm<sup>2</sup>) at 800 RPM or 37–75 psi (2.6–5.3 kg/cm<sup>2</sup>) at 1600 RPM. Oil pressure relief occurs at 75 psi (5.3 kg/cm<sup>2</sup>).

## OIL PUMP

#### Removal & Disassembly

Remove oil pump retaining bolts. DO NOT move oil pick-up pipe in pump body. If oil pick-up pipe is moved, pick-up pipe must be replaced to ensure an airtight seal. Remove pump cover. Disassemble pump.

#### Inspection

1) Inspect for wear and damage. Place Plastigage across full width of each gear. Temporarily install cover, and tighten bolts to 70 INCH lbs. (8 N.m). Remove cover. Examine Plastigage to determine end clearance.

2) Rotate gears, and measure clearance between each tooth and oil pump body, directly opposite point of mesh. Replace oil pump if not within specification. See OIL PUMP SPECIFICATIONS table.

#### OIL PUMP SPECIFICATIONS TABLE

Application	In. (mm)
Gear End Clearance .....	.002–.006 (.05–.15)
Gear-to-Body Clearance .....	.002–.004 (.05–.10)

#### Reassembly & Installation

1) Apply sealant to pick-up pipe and pump cover area prior to installation. To install pick-up tube, use Pipe Installer (7624). Ensure pick-up pipe support bracket is aligned with pump cover bolt. If relief valve is replaced, ensure replacement valve is same diameter as that removed.

2) Fill pump cavity with petroleum jelly. Install cover. Tighten cover bolts to specification. Check pump gears for freedom of rotation. Install new gasket and oil pump. Tighten retaining bolts to specification. See TORQUE SPECIFICATIONS table.

## TORQUE SPECIFICATIONS

#### TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Camshaft Sprocket Bolt .....	80 (108)
Connecting Rod Cap Nuts .....	33 (45)
Cylinder Head Bolts (1)	
Stage 1 .....	22 (30)
Stage 2 .....	45 (61)
Stage 3 .....	(2) 110 (149)
Drive Plate-To-Converter Bolts .....	40 (54)
Exhaust Manifold Bolts (3)	
Bolt No. 1 .....	30 (41)
Bolt No. 2–5 .....	23 (31)

Nut No. 6 & 7 .....	30	(41)
Fan Bolts .....	18	(24)
Flexplate-To-Crankshaft Bolts .....	(4) 50	(68)
Flywheel-To-Crankshaft Bolts .....	(4) 50	(68)
Intake Manifold Bolts (3)		
Bolt No. 1 .....	30	(41)
Bolt No. 2-5 .....	23	(31)
Nut No. 6 & 7 .....	30	(41)
Main Bearing Cap Bolts		
Stage 1 .....	40	(54)
Stage 2 .....	70	(95)
Stage 3 .....	80	(108)
Oil Pump Retaining Bolts		
Long .....	17	(23)
Short .....	10	(14)
Oxygen (O2) Sensor .....	23	(31)
Pulley-To-Vibration Damper Bolts .....	20	(27)
Rocker Arm Bolts .....	21	(28)
Starter Bolts .....	33	(45)
Throttle Body-To-Intake Bolts .....	10	(14)
Vibration Damper Bolt .....	(5) 80	(108)
Water Pump Bolts .....	25	(34)

INCH Lbs. (N.m)

Front Cover-To-Block Bolts .....	62	(7)
Oil Pan Bolts		
1/4" X 20 .....	114	(13)
5/16" X 18 .....	156	(18)
Oil Pump Cover Bolts .....	70	(8)
Valve Cover Bolts .....	85	(9)

- (1) - Tighten in sequence. See Fig. 3.
- (2) - All except bolt No. 7. Tighten bolt No. 7 to 100 ft. lbs. (136 N.m).
- (3) - Tighten bolts in sequence. See Fig. 2.
- (4) - Tighten to specification and an additional 60 degrees.
- (5) - With bolt cleaned and threads lubricated with oil.

## ENGINE SPECIFICATIONS

### GENERAL ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS TABLE

Application	Specification
Displacement .....	150 Cu. In. (2.5L)
Bore .....	3.88" (98.5 mm)
Stroke .....	3.19" (81.0 mm)
Compression Ratio	
Cherokee .....	9.2:1
Wrangler .....	9.1:1
Fuel System .....	PFI
Horsepower @ RPM	
Cherokee .....	130 @ 5250
Wrangler .....	123 @ 5250
Torque Ft. Lbs. @ RPM	
Cherokee .....	149 @ 3000
Wrangler .....	139 @ 3250

## CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECS TABLE

Application	In. (mm)
Crankshaft	
End Play .....	.0015-.0065 (.038-.165)
Runout .....	(1)
Main Bearings	
Journal Diameter .....	2.4996-2.5001 (63.490-63.503)
Journal Out-Of-Round .....	.0005 (.013)
Journal Taper .....	.0005 (.013)
Oil Clearance .....	.0010-.0025 (.025-.063)
Connecting Rod Bearings	
Journal Diameter .....	2.0934-2.0955 (53.172-53.226)
Journal Out-Of-Round .....	.0005 (.013)
Journal Taper .....	.0005 (.013)
Oil Clearance .....	.0015-.0025 (.038-.063)

(1) - Information not available from manufacturer.

## CONNECTING RODS SPECIFICATIONS

CONNECTING RODS SPECIFICATIONS TABLE

Application	In. (mm)
Bore Diameter	
Pin Bore .....	.9288-.9298 (23.591-23.617)
Crankpin Bore .....	2.2080-2.2085 (56.083-56.096)
Center-To-Center Length .....	6.123-6.127 (155.52-155.63)
Maximum Bend .....	.003 (.08)
Maximum Twist .....	.006 (.15)
Side Play .....	.010-.019 (.25-.48)

## PISTONS, PINS & RINGS SPECIFICATIONS

PISTONS, PINS & RINGS SPECIFICATIONS TABLE

Application	In. (mm)
Piston	
Clearance .....	.0013-.0021 (.033-.053)
Diameter .....	(1)
Pins	
Diameter .....	.9306-.9307 (23.637-23.640)
Piston Fit .....	.0003-.0007 (.007-.018)
Rod Fit .....	Press Fit
Rings	
No. 1 & 2	
End Gap .....	.010-.020 (.25-.51)
Side Clearance .....	.0017-.0032 (.043-.081)
No. 3 (Oil)	
End Gap .....	.015-.055 (.38-1.40)
Side Clearance .....	.001-.010 (.03-.24)

(1) - Information is not available from manufacturer.  
Replace pistons if piston clearance exceeds  
.004" (.10 mm).

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## CYLINDER BLOCK SPECIFICATIONS

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CYLINDER BLOCK SPECIFICATIONS TABLE

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Application	In. (mm)
Cylinder Bore	
Standard Diameter .....	3.875-3.877 (98.42-98.48)
Maximum Taper .....	.001 (.03)
Maximum Out-Of-Round .....	.001 (.03)
Minimum Deck Height .....	9.320 (236.73)
Maximum Deck Warpage .....	.008 (.20)

---

## VALVES & VALVE SPRINGS SPECIFICATIONS

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VALVES & VALVE SPRINGS SPECIFICATIONS TABLE

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Application	Specification
Intake Valves	
Face Angle .....	45 °
Head Diameter .....	1.90" (48.3 mm)
Minimum Margin .....	.031" (.79 mm)
Minimum Refinish Length .....	4.889" (124.18 mm)
Stem Diameter .....	.311-.312" (7.89-7.92 mm)
Valve Tip Maximum Refinish .....	.010" (.25 mm)
Exhaust Valves	
Face Angle .....	45 °
Head Diameter .....	1.50" (38.1 mm)
Minimum Margin .....	.031" (.79 mm)
Minimum Refinish Length .....	4.927" (125.15 mm)
Stem Diameter .....	.311-.312" (7.90-7.92 mm)
Valve Tip Maximum Refinish .....	.010" (.25 mm)
Valve Springs	
Free Length .....	2.0" (51 mm)
Installed Height .....	(1)
Out-Of-Square .....	(1)
Pressure (2)	
Valve Closed .....	80-90 @ 1.64 (36.3-40.8 @ 40.8)
Valve Open .....	200 @ 1.216 (90.7 @ 30.9)

(1) - Information is not available from manufacturer.

(2) - Lbs. @ In. (kg @ mm).

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## CYLINDER HEAD SPECIFICATIONS

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CYLINDER HEAD SPECIFICATIONS TABLE

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Application	Specification
Cylinder Head Height .....	(1)
Maximum Warpage .....	.008" (.20 mm)
Valve Seats	
Intake Valve	
Seat Angle .....	44.5-45 °
Seat Width .....	.040-.060" (1.02-1.52 mm)
Maximum Seat Runout .....	.0025" (.063 mm)
Exhaust Valve	
Seat Angle .....	44.5-45 °

Seat Width .....	.040-.060"	(1.02-1.52 mm)
Maximum Seat Runout .....	.0025"	(.063 mm)
Seat Bore Diameter .....		(1)
Valve Guides		
Intake Valve		
Valve Guide I.D. ....	.313-.314"	(7.95-7.98 mm)
Valve Stem-To-Guide		
Oil Clearance .....	.001-.003"	(.03-.08 mm)
Exhaust Valve		
Valve Guide I.D. ....	.313-.314"	(7.95-7.98 mm)
Valve Stem-To-Guide		
Oil Clearance .....	.001-.003"	(.03-.08 mm)

(1) - Information is not available from manufacturer.

## CAMSHAFT SPECIFICATIONS

CAMSHAFT SPECIFICATIONS TABLE

Application	In.	(mm)
Bore Diameter .....		(1)
End Play .....	(2) 0	(0)
Journal Diameter		
No. 1 .....	2.029-2.030	(51.54-51.56)
No. 2 .....	2.019-2.020	(51.28-51.31)
No. 3 .....	2.009-2.010	(51.03-51.05)
No. 4 .....	1.999-2.000	(50.78-50.80)
Journal Runout .....		(3)
Lobe Height .....		(1)
Lobe Lift .....	.265	(6.73)
Oil Clearance .....	.001-.003	(.03-.08)

(1) - Information is not available from manufacturer.

(2) - Engine running.

(3) - Information is not available from manufacturer.  
Manufacturer specifies .001" (.03 mm) maximum base circle runout.

## VALVE LIFTERS SPECIFICATIONS

VALVE LIFTERS SPECIFICATIONS TABLE

Application	In.	(mm)
Bore Diameter .....	.9055-.9065	(22.987-23.025)
Lifter Diameter .....	.9040-.9045	(22.962-22.974)
Oil Clearance .....	.001-.002	(.03-.05)

## 4.0L 6-CYL - VIN [S]

### 1993 Jeep Cherokee

1993 CHRYSLER CORP. ENGINES  
4.0L 6-Cylinder

Jeep: Cherokee, Grand Cherokee, Wrangler

### ENGINE IDENTIFICATION

NOTE: For engine repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article in the GENERAL INFORMATION section.

The Vehicle Identification Number (VIN) is located on the upper left side of the dash and is visible through the windshield. The eighth character identifies engine size.

#### ENGINE IDENTIFICATION CODES TABLE

Application	VIN Code
4.0L 6-Cylinder PFI .....	S

Some engines are manufactured with oversize or undersize components. These engines are identified by a letter code stamped on a boss between ignition coil and distributor. Letters are decoded as follows:

- \* "B" indicates all cylinder bores are .010" (.25 mm) oversize.
- \* "C" indicates all camshaft bearing bores are .010" (.25 mm) oversize.
- \* "M" indicates all main bearing journals are .010" (.25 mm) undersize.
- \* "P" indicates one or more connecting rod journals are .010" (.25 mm) undersize.
- \* "PM" indicates all main journals and one or more rod journal are .010" (.25 mm) undersize.

### ADJUSTMENTS

#### VALVE CLEARANCE ADJUSTMENT

Engine is equipped with hydraulic valve lifters. Valve adjustment is not required.

### REMOVAL & INSTALLATION

#### \* PLEASE READ THIS FIRST \*

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

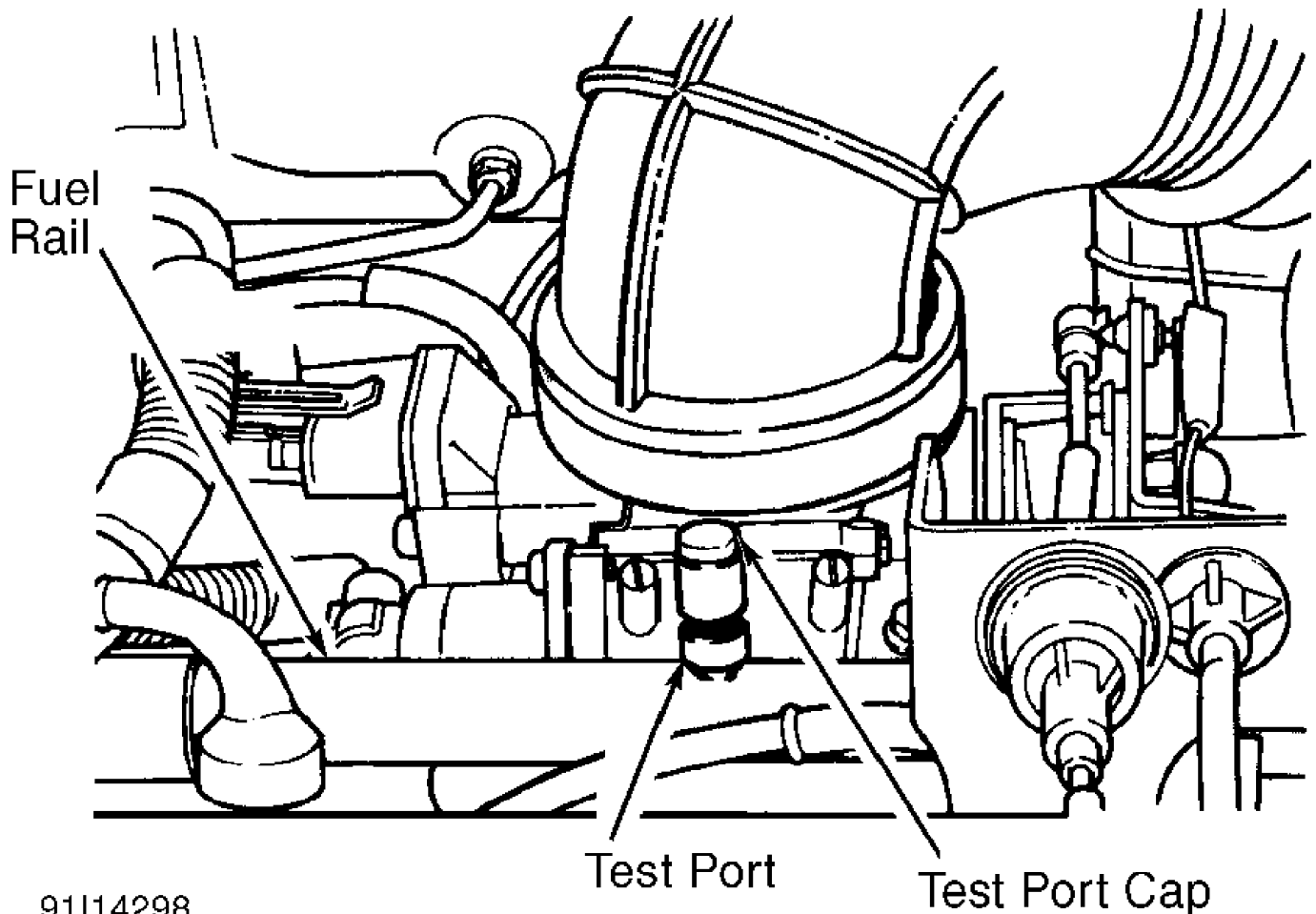
NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.



## FUEL PRESSURE RELEASE

**CAUTION:** Fuel system is under constant pressure. This pressure must be released before disconnecting or servicing any fuel supply or return system component. Wear proper eye protection when releasing fuel system pressure.

Disconnect negative battery cable. Remove fuel filler cap. Remove cap from pressure test port on fuel rail. See Fig. 1. Place shop towels around pressure test port to absorb spilled fuel. Press test port valve with a small screwdriver or punch wrapped in shop towels. Remove shop towels and dispose of properly. Install pressure test port cap.



91114298

Fig. 1: Locating Fuel Pressure Bleeding Test Port  
Courtesy of Chrysler Corp.

**CAUTION:** Always replace "O" rings, spacers and retainers whenever fuel system quick-connect fittings are disconnected. Ensure fuel connections are secure by verifying that only retaining tabs protrude from connectors and by pulling on tubes to verify they are locked into place.

## COOLING SYSTEM BLEEDING

**CAUTION:** Engine coolant may be hot. To avoid scalding, carefully

release system pressure before removing radiator cap or opening drain cock.

Add coolant only when engine is cold. Fill radiator completely and install pressure cap. Fill reserve/overflow tank to FULL mark. Operate engine until it reaches normal operating temperature. Shut off engine and allow it to cool. Recheck coolant level in reserve/overflow tank as necessary.

## ENGINE

Removal (Except Wrangler)

1) Remove hood. Disconnect battery cables. Remove battery. Remove air cleaner. Unplug quick-connect vacuum hose fittings at intake manifold. Drain cooling system. Remove radiator hoses and radiator support. Disconnect harness from electric fan motor (if equipped). Remove fan shroud and fan. Disconnect transmission cooler lines (if equipped). Remove radiator.

2) Discharge A/C system (if equipped) using approved refrigerant recovery/recycling equipment. Remove A/C service valves. Cap compressor ports. Remove A/C condenser. Disconnect heater hoses at water pump and thermostat housing. Disconnect cruise control (if equipped) and throttle linkage. Disconnect distributor wiring, oil pressure sender wire and fuel injection wire harness at each injector. Tag connectors for installation reference.

3) Disconnect line pressure cable to A/T (if equipped). Release fuel pressure. See FUEL PRESSURE RELEASE. Disconnect fuel supply quick-connect fittings at fuel rail. Remove fuel line bracket from intake manifold. Remove check valve from power brake booster (if equipped). Disconnect power steering hoses at steering gear (if equipped). Drain power steering pump reservoir. Cap power steering hoses and fittings.

4) Tag and disconnect any remaining vacuum hoses and electrical connectors as required. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Remove starter and flywheel cover. Disconnect oxygen (O2) sensor. Disconnect engine speed sensor.

5) On A/T models, mark converter and flexplate for installation reference. Remove converter-to-flexplate bolts. Remove upper and loosen lower bellhousing bolts. Remove engine mount bracket bolts. Lower vehicle.

6) Attach lifting device to engine. Lift engine from front supports. Place support under bellhousing. Remove remaining bellhousing bolts. Remove engine.

Removal (Wrangler)

1) Pad windshield frame using cloth. Raise hood, and rest it against windshield frame. Drain cooling system. Disconnect battery cables. Remove battery. Disconnect wiring from alternator, ignition coil, distributor, oil pressure sending unit and fuel injection wiring harness. Disconnect wires at starter solenoid and injector harness connector.

2) Disconnect fuel line quick-connect couplings at fuel rail. Remove fuel line bracket from intake manifold. Remove engine ground strap. Remove air cleaner. Disconnect vacuum purge hose from vapor canister tee. Unplug idle speed actuator connector. Disconnect throttle cable and remove it from bracket.

3) Disconnect throttle rod at bellcrank. Disconnect cruise control cable (if equipped). Unplug O2 sensor connector. Disconnect coolant hoses at radiator, intake manifold and thermostat housing. Remove fan shroud and radiator. Remove fan and spacer. Install a 5/16 x 1/2" bolt through fan pulley into water pump flange to maintain pulley and water pump alignment.

4) Remove check valve from power brake booster (if equipped). Disconnect power steering hoses at steering gear (if equipped). Drain power steering pump reservoir. Cap power steering hoses and fittings.

5) Tag and disconnect any remaining hoses or electrical connectors. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Remove starter. Remove flywheel housing access cover. Remove engine mount through-bolts. Remove upper bellhousing bolts. Loosen lower bellhousing bolts.

6) Lower vehicle. Attach lifting device to engine. Raise engine from front supports. Place support under bellhousing. Remove remaining bellhousing bolts. Lift engine from engine compartment.

#### Installation (All Models)

1) Remove engine mount cushions from brackets to aid alignment of engine and transmission. Replace fuel line quick-connect "O" rings, spacers and retainers.

2) Be careful not to damage trigger wheel on flywheel when installing engine into vehicle with automatic transmission. To complete installation, reverse removal procedure. Adjust throttle and cruise control linkage (if equipped). Tighten bolts to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Check fluid levels, and refill if necessary.

## INTAKE MANIFOLD

#### Removal

1) Disconnect negative battery cable. Remove air inlet from throttle plate assembly. Remove air cleaner. Disconnect throttle and cruise control (if equipped) cables. Disconnect line pressure cable to A/T (if equipped).

2) Unplug all electrical connectors from intake manifold. Release fuel system pressure. See FUEL PRESSURE RELEASE. Disconnect fuel line quick-connect fittings at fuel rail. Loosen accessory drive belt and tensioner.

3) Remove power steering pump and bracket. Wire pump aside. Remove fuel rail retaining bolts. Remove fuel rail and injector assembly. Raise and support vehicle. Disconnect exhaust pipe from exhaust manifold. Lower vehicle. Remove retaining bolts. Remove intake and exhaust manifolds as an assembly.

#### Installation

1) Ensure all gasket surfaces are clean. Install NEW gasket. Install exhaust manifold and tighten bolt No. 3 finger tight. Install intake manifold and remaining bolts loosely. Replace fuel line quick-connect "O" rings, spacers and retainers.

2) Tighten bolts in proper sequence to specification. See Fig. 2. See TORQUE SPECIFICATIONS TABLE at the end of this article. Reverse removal procedure to complete installation.

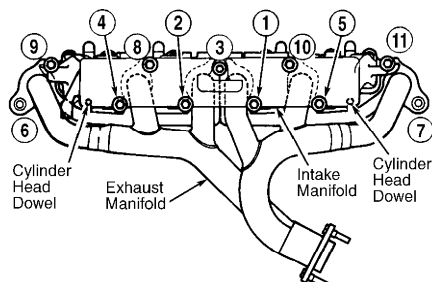


Fig. 2: Manifold Tightening Sequence  
Courtesy of Chrysler Corp.

## EXHAUST MANIFOLD

### Removal & Installation

Remove exhaust manifold with intake manifold. See INTAKE MANIFOLD.

## CYLINDER HEAD

### Removal

1) Disconnect negative battery cable. Drain cooling system. Remove air cleaner and fuel pipe. Remove molded hoses from cylinder head cover. Remove cylinder head cover.

2) Remove rocker arms, bridges, pivots and push rods. See ROCKER ARMS. Tag all parts for reassembly reference. Loosen serpentine drive belt at power steering pump (if equipped) or at idler pulley. Remove alternator bracket-to-cylinder head bolt. Disconnect power steering pump bracket. DO NOT disconnect hoses. Wire power steering pump aside.

3) Remove manifolds. See INTAKE MANIFOLD and EXHAUST MANIFOLD. Remove A/C compressor bracket bolts from cylinder head (if equipped). Loosen through bolt at bottom of A/C compressor bracket. Remove A/C compressor, and wire it aside.

4) Tag and disconnect spark plug wires. Remove spark plugs. Disconnect temperature sending unit. Remove ignition coil and bracket assembly.

5) Remove cylinder head bolts. Pull bolt No. 14 out as far as possible and hold in position using tape. Bolt No. 14 cannot be removed until head is moved forward. Remove cylinder head. Stuff clean lint-free shop towels into cylinder bores.

### Inspection

1) Inspect cylinder head for cracks and damage. Using straightedge, check cylinder head for warpage across bolt holes and diagonals. Repair or replace cylinder head if warpage exceeds specification or damage exists. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

2) Cylinder head bolts may only be reused once. If this is first time cylinder head has been removed, put a dab of paint on head of each bolt. If bolts already have paint on them or if it is unknown whether bolts have been used before, discard bolts and replace them with NEW head bolts.

### Installation

1) Clean carbon from combustion chambers and tops of pistons. Ensure all gasket surfaces, head bolts and head bolt holes are clean. Install NEW cylinder head gasket with numbers or word "TOP" upward. DO NOT apply gasket sealant to cylinder head gasket. Ensure all holes are aligned. Install cylinder head bolt No. 14, and hold in raised position using tape. Cylinder head bolt No. 14 cannot be installed after head is in position on block. Install cylinder head.

2) Apply sealant to threads of cylinder head bolt No. 11 before installation. Install cylinder head bolts. Tighten all bolts to specification in 3 stages and in sequence. During final tightening stage, bolt No. 11 will be tightened to a lower torque than others. See Fig. 3. See TORQUE SPECIFICATIONS TABLE at the end of this article.

3) To install remaining components, reverse removal procedure. Install all valve train components into original locations. Adjust A/T linkage. Refill cooling system. Start engine, and check for leaks.

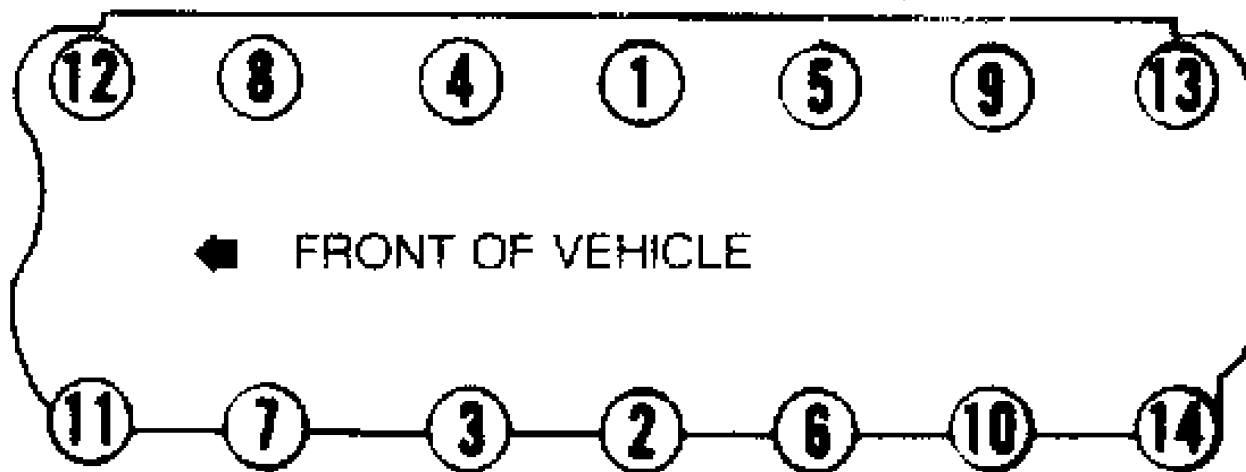


Fig. 3: Cylinder Head Bolt Tightening Sequence  
Courtesy of Chrysler Corp.

### FRONT COVER OIL SEAL

#### Removal

1) Disconnect negative battery cable. Remove drive belts, fan shroud, fan and hub assembly. Remove accessory drive pulley. Remove vibration damper retaining bolt and washer.

2) Using Puller (8068), remove vibration damper and key. Remove front cover oil seal.

#### Installation

1) Position seal on Seal Installer (6139), with seal open end facing toward cover. Apply thin coat of RTV sealant on outside diameter of seal. Lightly coat crankshaft with engine oil.

2) Position installer over end of crankshaft. Insert draw screw into end of crankshaft. Tighten draw screw nut until seal is fully seated in front cover. Remove installer. Check seal for proper installation. To complete installation, reverse removal procedure.

### TIMING CHAIN & SPROCKETS

#### Removal

1) Disconnect negative battery cable. Remove drive belts, fan shroud, fan and hub assembly. Remove accessory drive pulley. Remove vibration damper retaining bolt and washer.

2) Using Puller (8068), remove vibration damper and key. Remove alternator bracket assembly and A/C compressor bracket (if equipped). Remove oil pan-to-front cover bolts. Remove cover-to-block retaining bolts. Remove front cover. Take care that tension spring and thrust pin do not fall out of camshaft preload bolt into oil pan. Remove tension spring and thrust pin from preload bolt. Rotate crankshaft until timing marks on sprockets are aligned. See Fig. 4. Remove preload bolt. Remove timing chain and sprockets as an assembly.

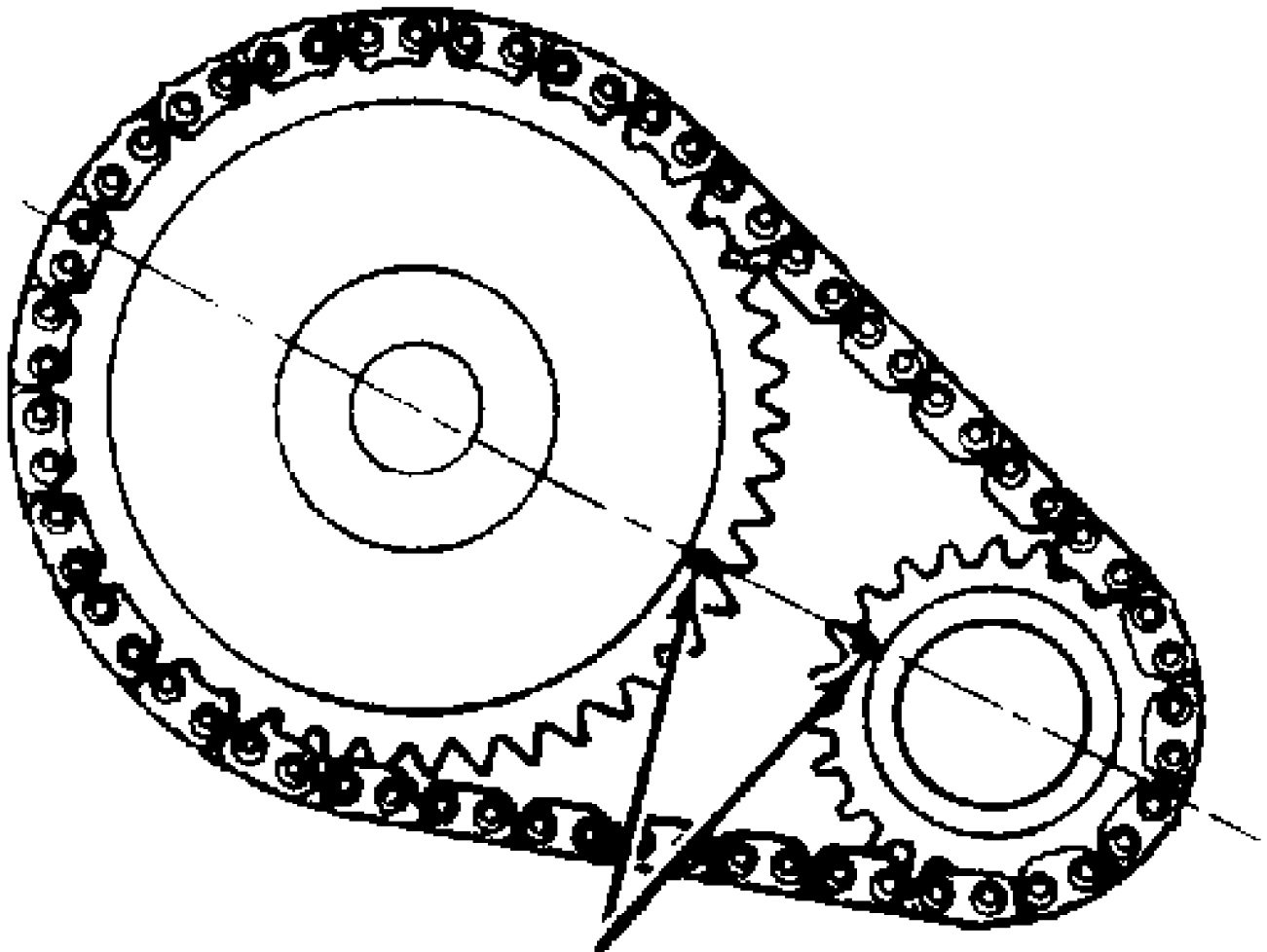
#### Installation

1) Install timing chain and sprockets as an assembly. Ensure timing marks align. Lubricate tension spring, thrust pin and thrust pin bore with Mopar Engine Oil Supplement (4318002) before installation. Install preload bolt and washer. Tighten to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article.

2) Verify proper installation by rotating crankshaft until

timing mark on camshaft is at approximately one o'clock position. Timing sprockets are installed correctly if 15 timing chain pins are between timing marks on both sprockets.

3) Install NEW front cover oil seal. Cut oil pan gasket tabs even with face of cylinder block. Remove tabs. Remove gasket from oil pan. Remove crankshaft oil seal from front cover. Clean front cover, oil pan and cylinder block gasket surfaces. Install front cover. To install remaining components, reverse removal procedure. See TORQUE SPECIFICATIONS TABLE at the end of this article.



## Timing Marks

Fig. 4: Aligning Sprocket Timing Marks  
Courtesy of Chrysler Corp.

### ROCKER ARMS

NOTE: All reused camshaft/valve train components must be reinstalled in original locations.

#### Removal

Remove valve cover. Alternately loosen rocker arm cap screws one turn at a time to prevent damaging bridges. Remove bridges, pivots, rocker arms and push rods. Tag all parts for installation reference.

#### Installation

1) Install all reused components into original locations. Ensure bottom ends of push rods are centered in valve lifters. Lubricate pivot contact area of rocker arms with Mopar Engine Oil Supplement (4318002). Install cap screws loosely, and then tighten alternately one turn at a time to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article.

2) Reverse removal procedure to complete installation. Pour remaining engine oil supplement over entire valve train. Supplement must remain in engine oil for at least 1000 miles (1600 km). Refill cooling system. Adjust ignition timing. Check for leaks.

### CAMSHAFT

#### Removal

1) Disconnect negative battery cable. Drain cooling system. Remove radiator and A/C condenser (if equipped), but DO NOT discharge system. Mark distributor and engine block for installation reference. Remove distributor and ignition wiring. Remove cylinder head. See CYLINDER HEAD.

2) Remove valve lifters using Hydraulic Valve Lifter Remover/Installer (C-4129-A). Tag each valve lifter for installation reference. Remove timing chain and sprockets. See TIMING CHAIN & SPROCKETS. Remove front bumper and/or grille as required. Remove camshaft.

#### Inspection

Inspect lobes, journals, bearings and distributor drive gear for wear. Inspect valve lifters for abnormal wear. If camshaft sprocket or chain rubs against engine front cover, examine oil pressure relief holes in rear camshaft journal and ensure they are free of debris. Replace components as necessary. If camshaft requires replacement, valve lifters MUST also be replaced.

#### Installation

1) Lubricate camshaft and dip valve lifters into MOPAR Engine Oil Supplement (4318002). Install camshaft. Reverse removal procedure to complete installation.

2) Pour remaining engine oil supplement over entire valve train. Supplement must remain in engine oil for at least 1000 miles (1600 km). Refill cooling system. Adjust ignition timing. Check for leaks.

### REAR CRANKSHAFT OIL SEAL

#### Removal

1) Remove transmission and flywheel or torque converter plate. Remove oil pan. See OIL PAN removal in this section. Remove rear main bearing cap (No. 7).

2) Push upper seal out of groove. Ensure crankshaft and seal groove are not damaged. Remove lower half of seal from bearing cap.

#### Installation

1) Remove the rear main bearing cap. Wipe the seal surface area of the crankshaft until it is clean. Apply a thin coat of engine oil. Position the upper seal into the cylinder block. The lip of the seal faces toward the front of the engine.

2) Place lower half of seal into bearing cap No. 7. Coat both sides of the lower seal end tabs w/Jeep Gasket-in-a-Tube, or equivalent. Do not apply sealant to the lip of the seal. Coat the outer curved surface of the lower seal with soap and the lip of the seal w/engine oil.

3) Position the lower seal into the bearing cap recess and seat it firmly. Be sure seal is flush with cylinder block pan rail. Apply Loctite 515, or equivalent on rear bearing cap. The bead should be 0.125" (3 mm) thick. Do not apply Loctite 515, or equivalent to lip of seal.

CAUTION: Do not apply Loctite 515, or equivalent to lip of seal.

4) Install the rear main bearing cap. Do not strike cap more than twice for proper engagement. Tighten all main bearing bolts to 80 ft-lbs (108 Nm) torque. Install oil pan gasket and oil pan. Install transmission inspection plate.

## **WATER PUMP**

### **Removal**

Disconnect negative battery cable. Drain coolant. Remove fan shroud retaining screws and drive belts. Remove fan. Disconnect heater hoses and lower radiator hose at water pump. Remove power steering pump bracket (if equipped) at water pump boss. Remove retaining bolts and water pump.

### **Installation**

Clean all gasket surfaces. Install water pump. Tighten bolts to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Ensure pump turns freely. Ensure belt is correctly installed or engine may overheat because pump rotates in wrong direction. To complete installation, reverse removal procedures. Fill cooling system.

## **OIL PAN**

### **Removal**

1) Disconnect negative battery cable. Raise and support vehicle at side sills. Drain engine oil. Disconnect exhaust pipe at exhaust manifold. Disconnect exhaust hanger at catalytic converter. Lower exhaust pipe. Remove starter. Remove flywheel access cover.

2) Position jackstand directly under vibration damper. Place wooden block between vibration damper and jackstand. Remove through bolts from engine mounts. Raise engine enough to remove oil pan. Remove oil pan retaining bolts. Remove oil pan by sliding it to rear.

### **Installation**

1) Ensure all gasket surfaces are clean. Fabricate 4 alignment dowels from 1 1/2 x 1/4" bolts. Cut heads off bolts and cut slot in end of bolts to allow removal with screwdriver. Install 2 dowels in timing cover and 2 dowels in block. Slide gasket over dowels into position against block and timing cover.

2) Install oil pan. Install sufficient bolts to hold oil pan in place. Remove alignment dowels. Install remaining oil pan bolts and tighten to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. To complete installation, reverse removal procedure. Fill crankcase. Start engine. Check for leaks.

## **OVERHAUL**

### **CYLINDER HEAD**

#### **Cylinder Head Service**

Inspect for cracks in combustion chambers, coolant passages, ports and exhaust valve seats. Using straightedge, check cylinder head for warpage across bolt holes and diagonals. Resurface or replace



cylinder head if warpage exceeds specification or damage exists. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valve Springs

Use Valve Spring Tester (C-647 or J-22738-02) to test each valve spring. Measure free length of each valve spring. Replace valve springs that do not meet specifications. See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS.

#### Valve Stem Oil Seals

Replace valve stem oil seals if they have deteriorated or whenever valves are serviced. Oil seals are marked "INT" and "EXH" for intake and exhaust valves, respectively.

#### Valve Guides

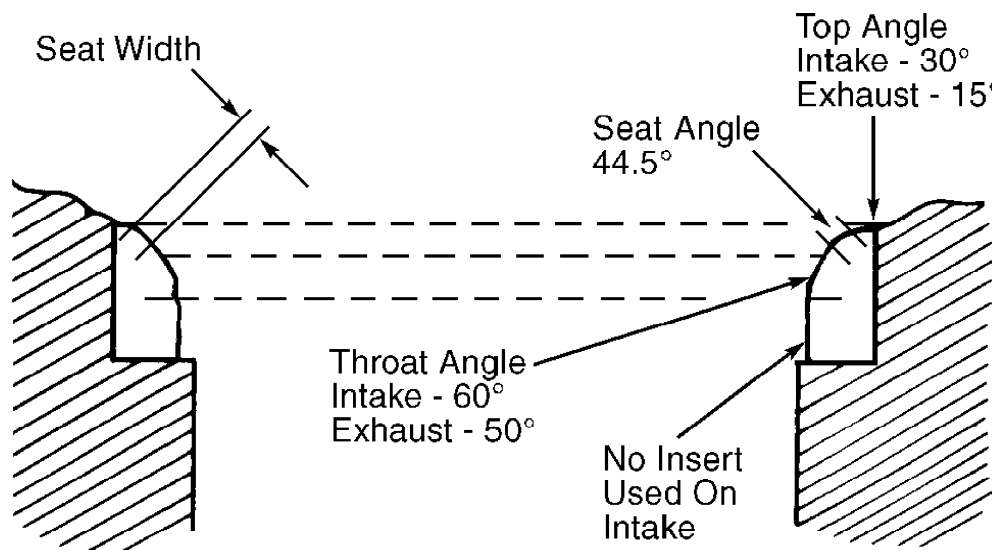
Measure diameter of valve guide approximately 3/8" (10 mm) from valve spring side of head, both parallel and at right angles to long axis of head. If difference between measurements exceeds .0025" (.063 mm), or if diameter exceeds specification by .003" (.08 mm), ream valve guide for oversize valve stem. Valve seats must be refaced after reaming valve guides. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valve Seats

Reface valve seats to specification. Remove only enough metal to provide smooth finish. Use tapered stones to obtain specified seat width. See Fig. 5. Seat width runout should not exceed .0025" (.063 mm) after refacing. See CYLINDER HEAD table under ENGINE SPECIFICATIONS.

#### Valves

Reface valves to specification. At least .031" (.79 mm) margin must remain after refacing valve. Valve stem tip can be resurfaced and chamfered when worn. DO NOT remove more than .01" (.25 mm). See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS.



91C14300

Fig. 5: Measuring Valve Seat Dimensions  
Courtesy of Chrysler Corp.

## VALVE TRAIN

#### Rocker Arms

Inspect pivot and valve stem contact surfaces of each rocker arm. Replace any rocker arm that is scuffed, pitted, cracked or excessively worn.

#### Push Rods

Inspect push rods for excessive wear. If wear is excessive because of lack of oil, replace and inspect corresponding valve lifter for excessive wear. Roll push rods on a flat surface to check for straightness. Replace push rod and/or valve lifter, if necessary. If wear exists along length of push rod, inspect cylinder head for obstruction.

### CYLINDER BLOCK ASSEMBLY

#### Piston & Rod Assembly

1) Position piston on support. See Fig. 6. Press piston pin from piston. Discard pin. Piston pin cannot be reused after removal. Inspect piston pin bore in connecting rod for nicks and burrs, and remove as necessary. Clean and dry piston pin bore and NEW piston pin.

2) Clean piston pin bore and replacement piston pin. Piston and piston pin must be at room temperature when measuring fit. Piston pin should fall through piston at room temperature. If pin jams in pin bore, replace piston.

3) Ensure arrow on piston crown is pointing up. Insert piston pin through piston pin bore and into connecting rod pin bore. Assemble connecting rod and piston so oil squirt hole faces camshaft and arrow on piston points to front of engine when installed.

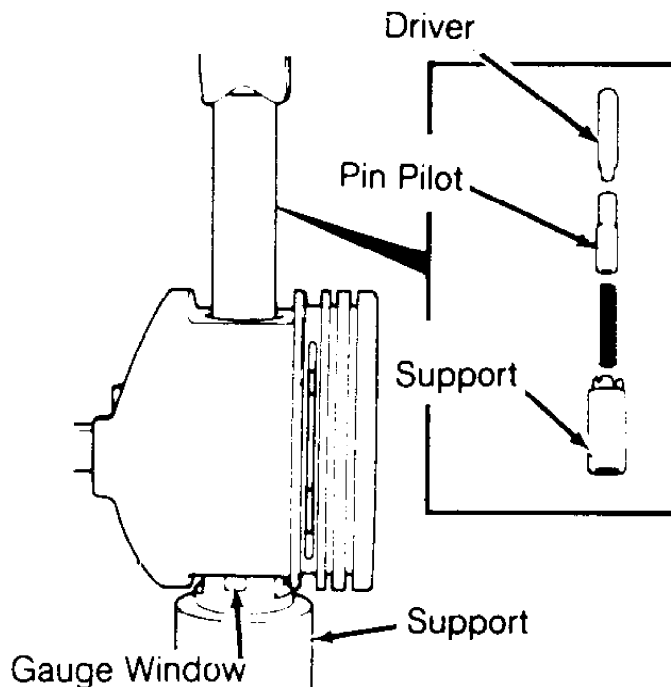


Fig. 6: Removing & Installing Piston Pin  
Courtesy of Chrysler Corp.

4) Press pin through rod and piston until pilot indexes with mark on support. Pin should be centered in rod. Piston pin

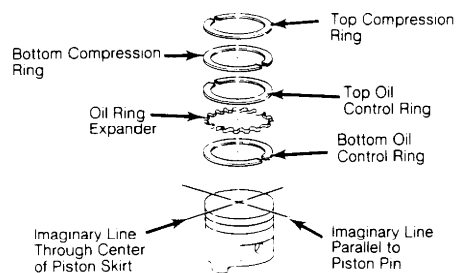
installation requires approximately 2000 lbs. (900 kg) of force. Replace connecting rod if noticeably less force is required, or if rod moves on pin.

#### Fitting Pistons

Measure cylinder bore 2 5/16" (59 mm) below top of bore. Measure piston diameter at right angle to piston pin at center line of pin. Piston clearance is difference between measurements. Pistons up to .004" (.10 mm) undersize may be enlarged by knurling or shot peening. Replace pistons if they are .004" (.10 mm) or more undersize.

#### Piston Rings

Install piston rings. Ensure ring end gap and side clearance are within specification. Install compression rings with dot(s) on ring surface toward top of piston. DO NOT interchange compression rings. Top ring has Gray scraping surface; second ring has Black scraping surface. Position ring end gaps in specified area. Ring gaps may vary 20 degrees from positions illustrated. See Fig. 7. See PISTONS, PINS & RINGS table under ENGINE SPECIFICATIONS.



93H75900

Fig. 7: Positioning Piston Ring Gaps  
Courtesy of Chrysler Corp.

#### Rod Bearings

1) Inspect bearings for wear or damage. Replace as necessary. Using Plastigage, check bearing clearance. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS. Bearings are available for standard and undersize applications.

2) If necessary, different size upper and lower bearings may be combined to obtain correct oil clearance. Lubricate bearing surfaces with oil before installation. Tighten bolts to specification. Check rod side play. Rotate crankshaft to ensure freedom of movement. See TORQUE SPECIFICATIONS TABLE at the end of this article. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table.

NOTE: Avoid combining bearing inserts in excess of .001" (.03 mm) difference in size. Odd size inserts must be on bottom (rod cap) side.

#### Crankshaft & Main Bearings

1) Inspect bearings for wear or damage. Replace as necessary. Using Plastigage, check bearing clearance. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS. Bearings are available in standard and undersize. If necessary, different size upper and lower bearings may be installed to obtain correct oil clearance. Lubricate bearings before installation.

NOTE: If different size bearings are used, odd size bearings must all be uniform in location (upper or lower). DO NOT use bearings with a thickness difference exceeding .001" (.03 mm).

2) Install upper bearing inserts. Install bearing caps and lower inserts. Tighten bearing caps in 3 stages to specification. Rotate crankshaft to ensure freedom of movement after tightening each cap. See TORQUE SPECIFICATIONS TABLE at the end of this article. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table.

#### Thrust Bearing

Check crankshaft end play. If end play is not within specification, replace thrust bearing. If end play is still not within specification, replace crankshaft.

#### Cylinder Block

1) Thoroughly clean all gasket surfaces. Using a tap, clean head bolt holes. Clean oil gallery by blowing compressed air into oil filter adapter, filter by-pass, oil gallery and crankshaft oil feed holes.

2) Measure cylinder bore diameter crosswise to cylinder block about 1/2" below top of bore. Repeat measurement at bottom of bore. Subtract smaller diameter from larger diameter to determine taper. Repeat measurements for each cylinder.

3) Repeat measurements with measuring device rotated 120 degrees. Repeat this step for a total of 3 measurements. Cylinder out-of-round is difference between measurements. Repeat for each cylinder.

4) Bore and hone cylinders for oversize pistons if taper or out-of-round exceeds specification. Move hone up and down to provide a 60-degree crosshatch pattern. DO NOT use a rigid hone or exceed 10 strokes per cylinder. See CYLINDER BLOCK table under ENGINE SPECIFICATIONS.

## LUBRICATION

### ENGINE OILING

An oil pump driven by distributor supplies oil through a full-flow oil filter into an internal oil passage. This passage provides oil to valve lifter bores and then to camshaft and crankshaft bearings. Oil then flows from hydraulic valve lifters through push rods to rocker arms.

#### Crankcase Capacity

Oil capacity is 6.0 qts. (5.7L) with filter change.

#### Oil Pressure

Minimum oil pressure should be 13 psi (89.6 kPa) at 600 RPM. Normal oil pressure should be 37-75 psi (255.1-517.1 kPa) above 1600 RPM. Oil pressure relief is 75 psi (517.1 kPa).

### OIL PUMP

#### Removal & Disassembly

Remove mounting bolts and oil pump. DO NOT move oil pick-up pipe in pump body. If oil pick-up pipe is moved, pick-up pipe MUST be replaced to ensure an airtight seal. Remove pump cover. Disassemble pump.

#### Inspection

Inspect for wear or damage. Place Plastigage across full width of each gear. Install cover temporarily and tighten bolts to 70 INCH lbs. (8 N.m). Remove cover. Examine Plastigage to determine end clearance. Measure clearance between each tooth and oil pump body directly opposite point of mesh. Replace oil pump if not within specifications. See OIL PUMP SPECIFICATIONS table.

## OIL PUMP SPECIFICATIONS TABLE

Application	In. (mm)
Gear End Clearance .....	.002-.006 (.05-.15)
Gear-to-Body Clearance .....	.002-.004 (.05-.10)

### Reassembly & Installation

1) Apply sealant to pick-up pipe and pump cover area prior to installation. To install pick-up pipe use Pipe Installer (7624). Ensure pick-up pipe support bracket aligns with pump cover bolt. If relief valve is replaced, ensure replacement valve is the same diameter as that removed.

2) Fill pump cavity with petroleum jelly. Install cover. Tighten cover bolts to specification. Check pump gears for freedom of rotation. Install NEW gasket and oil pump. Tighten retaining bolts to specification. See TORQUE SPECIFICATIONS table.

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Camshaft Sprocket Preload Bolt .....	80 (108)
Connecting Rod Cap Nut .....	33 (45)
Converter-To-Flexplate Bolts .....	(1)
Cylinder Head Bolts (2)	
Stage 1 .....	22 (30)
Stage 2 .....	45 (61)
Stage 3 .....	(2) 110 (149)
Exhaust Manifold Bolts (3)	
Bolts No. 1-5 .....	24 (33)
Bolts No. 6 & 7 .....	17 (23)
Bolts No. 8-11 .....	24 (33)
Fan Bolt .....	18 (24)
Flexplate-To-Converter Bolts .....	40 (54)
Flexplate-To-Crankshaft Bolts .....	55 (75)
Flywheel-To-Crankshaft Bolts .....	(1)
Intake Manifold Bolts (3)	
Bolts No. 1-5 .....	24 (33)
Bolts No. 6 & 7 .....	17 (23)
Bolts No. 8-11 .....	24 (33)
Main Bearing Cap Bolts	
Stage 1 .....	40 (54)
Stage 2 .....	70 (95)
Stage 3 .....	80 (108)
Oil Pump Retaining Bolts	
Long .....	17 (23)
Short .....	10 (14)
Pulley-To-Vibration Damper Bolts .....	20 (27)
Rocker Arm Bolts .....	21 (29)
Starter Bolts .....	33 (45)
Vibration Damper Bolt (4) .....	80 (108)
Water Pump Bolts .....	22 (30)

INCH Lbs. (N.m)

Front Cover Bolts .....	62 (7)
Oil Pan Bolts	

1/4" X 20 .....	114 (13)
5/16" X 18 .....	156 (18)
Oil Pump Cover Bolts .....	70 (8)
Valve Cover Bolts .....	80 (9)

- (1) - Information is not available from manufacturer.  
(2) - All bolts except No. 11. Tighten bolt No. 11 to 100 ft. lbs. (136 N.m) See Fig. 3.  
(3) - Tighten in sequence. See Fig. 2.  
(4) - With bolt cleaned and threads lubricated with oil.

## ENGINE SPECIFICATIONS

### GENERAL ENGINE SPECIFICATIONS

#### GENERAL SPECIFICATIONS

Application	Specification
Displacement .....	242 Cu. In. (4.0L)
Bore .....	3.88" (98.5 mm)
Stroke .....	3.44" (87.4 mm)
Compression Ratio .....	8.8:1
Fuel System .....	PFI
Horsepower @ RPM	
Except Wrangler .....	190 @ 4750
Wrangler .....	180 @ 4750
Torque Ft. Lbs. @ RPM	
Except Wrangler .....	225 @ 4000
Wrangler .....	220 @ 4000

### CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECIFICATIONS

#### CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS TABLE

Application	In. (mm)
Crankshaft	
End Play .....	.0015-.0065 (.038-.165)
Runout .....	(1)
Main Bearings	
Journal Diameter .....	2.4996-2.5001 (63.489-63.502)
Journal Out-Of-Round .....	.0005 (.013)
Journal Taper .....	.0005 (.013)
Oil Clearance .....	.0010-.0025 (.025-.064)
Connecting Rod Bearings	
Journal Diameter .....	2.0934-2.0955 (53.172-53.226)
Journal Out-Of-Round .....	.0005 (.013)
Journal Taper .....	.0005 (.013)
Oil Clearance .....	.0015-.0025 (.038-.064)

- (1) - Information is not available from manufacturer.

### CONNECTING RODS SPECIFICATIONS

#### CONNECTING RODS TABLE

Application	In. (mm)
-------------	----------

Bore Diameter	
Pin Bore	.9288-.9298 (23.591-23.617)
Crankpin Bore	2.2080-2.2085 (56.083-56.096)
Center-To-Center Length	6.123-6.127 (155.52-155.63)
Maximum Bend	.003 (.08)
Maximum Twist	.006 (.15)
Side Play	.010-.019 (.25-.48)

## PISTONS, PINS & RINGS SPECIFICATIONS

PISTONS, PINS & RINGS TABLE

Application	In. (mm)
Pistons	
Clearance	.0013-.0021 (.033-.053)
Diameter	(1)
Pins	
Diameter	.9306-.9307 (23.637-23.640)
Piston Fit	.0003-.0007 (.007-.018)
Rod Fit	Press Fit
Rings	
No. 1	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0010-.0032 (.025-.081)
No. 2	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0017-.0032 (.043-.081)
No. 3 (Oil)	
End Gap	.010-.025 (.25-.64)
Side Clearance	.001-.009 (.03-.23)

(1) - Information is not available from manufacturer.  
 Replace pistons if piston clearance exceeds .004"  
 (.10 mm).

## CYLINDER BLOCK SPECIFICATIONS

CYLINDER BLOCK TABLE

Application	In. (mm)
Cylinder Bore	
Standard Diameter	3.8751-3.8775 (98.427-98.488)
Maximum Taper	.001 (.03)
Maximum Out-Of-Round	.001 (.03)
Minimum Deck Height	9.429 (239.49)
Maximum Warp	.008 (.20)

## VALVES & VALVE SPRINGS SPECIFICATIONS

VALVES & VALVE SPRINGS TABLE

Application	Specification
Intake Valves	
Face Angle	45 °
Head Diameter	1.91" (48.5 mm)
Minimum Margin	.031" (.79 mm)
Minimum Refinish Length	4.822" (122.47 mm)

Stem Diameter .....	.312" (7.92 mm)
Valve Tip Maximum Refinish .....	.010" (.25 mm)
Exhaust Valves	
Face Angle .....	45 °
Head Diameter .....	1.5" (38.1 mm)
Minimum Margin .....	.031" (.79 mm)
Minimum Refinish Length .....	4.837" (122.86 mm)
Stem Diameter .....	.312" (7.92 mm)
Valve Tip Maximum Refinish .....	.010" (.25 mm)
Valve Springs	
Free Length .....	1.82" (46.2 mm)
Installed Height .....	1.625" (41.29 mm)
Out-Of-Square .....	(1)
Spring Pressure (2)	
Valve Closed .....	66-74 @ 1.625 (29.94-33.56 @ 41.28)
Valve Open .....	205-220 @ 1.2 (92.98-99.78 @ 30.48)

(1) - Information is not available from manufacturer.  
(2) - Lbs. @ In. (kg @ mm).

## CYLINDER HEAD SPECIFICATIONS

CYLINDER HEAD TABLE

Application	Specification
Cylinder Head Height .....	(1)
Maximum Warpage .....	.008" (.20 mm)
Valve Seats	
Intake Valve	
Seat Angle .....	44.5 °
Seat Width .....	.040-.060" (1.02-1.52 mm)
Maximum Seat Runout .....	.0025" (.064 mm)
Seat Bore Diameter .....	(1)
Exhaust Valve	
Seat Angle .....	44.5 °
Seat Width .....	.040-.060" (1.02-1.52 mm)
Maximum Seat Runout .....	.0025" (.064 mm)
Seat Bore Diameter .....	(1)
Valve Guides	
Intake Valve	
Valve Guide I.D. ....	.312" (7.9 mm)
Valve Stem-To-Guide	
Oil Clearance .....	.001-.003" (.03-.08 mm)
Exhaust Valve	
Valve Guide I.D. ....	.312" (7.9 mm)
Valve Stem-To-Guide	
Oil Clearance .....	.001-.003" (.03-.08 mm)

(1) - Information is not available from manufacturer.

## CAMSHAFT SPECIFICATIONS

CAMSHAFT TABLE

Application	In. (mm)
Bore Diameter .....	(1)
End Play (2) .....	0 (0)
Journal Diameter	
No. 1 .....	2.029-2.030 (51.54-51.56)



No. 2	.....	2.019-2.020	(51.28-51.31)
No. 3	.....	2.009-2.010	(51.03-51.05)
No. 4	.....	1.999-2.000	(50.78-50.80)
Journal Runout	.....		(3)
Lobe Height	.....		(1)
Lobe Lift	.....	.253	(6.43)
Oil Clearance	.....	.001-.003	(.03-.08)

- (1) - Information is not available from manufacturer.  
(2) - Engine running.  
(3) - Information is not available from manufacturer.  
Manufacturer specifies .001" (.03 mm) maximum base  
circle runout.

## VALVE LIFTERS SPECIFICATIONS

VALVE LIFTERS TABLE

Application	In. (mm)
Bore Diameter	..... .9055-.9065 (22.999-23.025)
Lifter Diameter	..... .9040-.9045 (22.962-22.974)
Oil Clearance	..... .001-.0025 (.025-.063)

## A - ENGINE/VIN ID

### 1993 Jeep Cherokee

1993 ENGINE PERFORMANCE  
Chrysler Corp. Jeep Introduction

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### 1993 MODEL COVERAGE

MODEL COVERAGE TABLE

MODEL	BODY CODE	ENGINE	ENGINE ID	FUEL SYSTEM	IGNITION SYSTEM
Cherokee	XJ	2.5L 4.0L	P S	MPI MPI	Magnetic Magnetic
Grand Cherokee	ZJ	4.0L 5.2L	S Y	MPI MPI	Magnetic Magnetic
Grand Wagoneer	ZJ	5.2L	Y	MPI	Magnetic
Wrangler	YJ	2.5L 4.0L	P S	MPI MPI	Magnetic Magnetic
(1) - Sequential Multi-Point Fuel Injection.					

### VIN DEFINITION

1 J 4 F J 5 8 S 9 P L 0 0 0 0 0 1  
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

- (1) - Indicates Nation of Origin.
- (2) - Indicates Manufacturer
- (3) - Indicates Vehicle Type
- (4) - Indicates GVWR
- (5) - Indicates Vehicle Line
- (6) - Indicates Vehicle Series
- (7) - Indicates Body Type
- (8) - Indicates Engine Code
- (9) - Indicates Check Digit
- (10) - Indicates Model Year
- (11) - Indicates Assembly Plant
- (12-17) - Indicates Plant Sequential Number

MODEL YEAR VIN CODE APPLICATION TABLE

VIN Code	Model Year
N .....	1992
P .....	1993

### ENGINE CODE LOCATION

2.5L

On machined surface, on right side of cylinder block, between cylinders No. 3 and No. 4.

4.0L

On machined surface, on right side of cylinder block, between cylinders No. 2 and No. 3.

5.2L

On machined surface, on left front corner of cylinder block, below cylinder head.

# ABBREVIATIONS

1993 Jeep Cherokee

## GENERAL INFORMATION

### COMMONLY USED ABBREVIATION

#### "A" ABBREVIATION TABLE

"A" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
A	Amperes
A/C	Air Conditioning
A/T	Automatic Transmission/Transaxle
AAP	Auxiliary Accelerator Pump
AB	Air Bleed
ABCV	Air Bleed Control Valve
ABDC	After Bottom Dead Center
ABRS	Air Bag Restraint System
ABS	Anti-Lock Brake System
AC	Alternating Current
ACC	A/C Clutch Compressor
ACCS	A/C Cycling Switch
ACCUM	Accumulator
ACCY	Accessory
ACT	Air Charge Temperature Sensor
ACV	Thermactor Air Control Valve
ADJ	Adjust or Adjustable
ADV	Advance
AFS	Airflow Sensor
AI	Air Injection
AIR or A.I.R.	Air Injection Reactor
AIS	Air Injection System
ALCL	Assembly Line Communications Link
ALDL	Assembly Line Diagnostic Link
ARC	Automatic Ride Control
ASCD	Automatic Speed Control Device
ASCS	Air Suction Control Solenoid
ASD	Auto Shutdown
ASDM	Air Bag System Diagnostic Module
ASV	Air Suction Valve
ATC	Automatic Temperature Control
ATDC	After Top Dead Center
ATF	Automatic Transmission Fluid
ATS	Air Temperature Sensor
AXOD	Automatic Transaxle Overdrive
Abs.	Absolute
Accy.	Accessory
Alt.	Alternator or Altitude
Amp.	Ampere
Assy.	Assembly
Auto.	Automatic
Aux.	Auxiliary
Avg.	Average

#### "B" ABBREVIATION TABLE

"B" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
B/P	Backpressure
BAC	By-Pass Air Control
BAP	Barometric Absolute Pressure Sensor
BARO	Barometric
BBDC	Before Bottom Dead Center
BCM	Body Control Module
BDC	Bottom Dead Center
BHP	Brake Horsepower
BLK	Black
BLU	Blue
BMAP	Barometric & Manifold Absolute Pressure Sensor
BOO	Brake On-Off Switch
BP	Barometric Pressure sensor
BPS	Barometric Pressure Sensor
BPT	Backpressure Transducer
BRN	Brown
BTDC	Before Top Dead Center
BTU	British Thermal Unit
BVSV	Bimetallic Vacuum Switching Valve
Baro.	Barometric
Batt.	Battery
Bbl.	Barrel (Example: 4-Bbl.)
Blst.	Ballast
Blwr.	Blower
Brkr.	Breaker

## "C" ABBREVIATION TABLE

"C" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
° C	Celsius (Degrees)
C(3) I	Computer Controlled Coil Ignition
C(4)	Computer Controlled Catalytic Converter
CANP	Canister Purge solenoid
CARB	California Air Resources Board
CAT	Catalytic Converter
CB	Circuit Breaker
CBD	Closed Bowl Distributor
CBVV	Carburetor Bowl Vent Valve
cc	Cubic Centimeter
CCC	Computer Command Control
CCD	Computer Controlled Dwell
CCM	Central Control Module
CCO	Converter Clutch Override
CCOT	Cycling Clutch Orifice Tube
CCW	Counterclockwise
CDI	Capacitor Discharge Ignition
CEC	Computerized Engine Control
CFI	Central Fuel Injection
CID	Cubic Inch Displacement
CID	Cylinder Identification sensor
CIS	Continuous Injection System
CIS-E	Continuous Injection System-Electronic
CKT	Circuit
CLR	Clear
CNG	Compressed Natural Gas

CO	Carbon Monoxide
CO2	Carbon Dioxide
CONV	Convertible
CP	Canister Purge
CPA	Connector Position Assurance
CPS	Crank Position Sensor
CTS	Coolant Temperature Sensor
CV	Check Valve or Constant Velocity
CVC	Constant Vacuum Control
CW	Clockwise
CYL or Cyl.	Cylinder
Calif.	California
Carb.	Carburetor
Chrg.	Charging
Circ.	Circuit
Cntrl.	Control
Comp.	Compressor or Compartment
Conn.	Connector
Cont.	Continued
Conv.	Convertible or Converter
Cu. In.	Cubic Inch
Cyl.	Cylinder

## "D" ABBREVIATION TABLE

"D" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
"D"	Drive
DBC	Dual Bed Catalyst
DC	Direct Current or Discharge
DDD	Dual Diaphragm Distributor
DERM	Diagnostic Energy Reserve Module
DFI	Digital Fuel Injection
DIC	Driver Information Center
DIS	Direct Ignition System
DIS	Distributorless Ignition System
DIST	Distribution
DISTR	Distributor
DK BLU	Dark Blue
DK GRN	Dark Green
DME	Digital Motor Electronics (Motronic System)
DOHC	Double Overhead Cam
DOT	Department of Transportation
DP	Dashpot
DRB-II	Diagnostic Readout Box
DVOM	Digital Volt/Ohm Meter (see VOM)
Def.	Defogger or Defroster
Def.	Defrost
Defog.	Defogger
Diag.	Diagnostic
Dist.	Distributor or Distribution
Dr.	Door

## "E" ABBREVIATION TABLE

"E" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
--------------	------------

EAC	Electric Assist Choke
EACV	Electric Air Control Valve
EBCM	Electronic Brake Control Module
ECA	Electronic Control Assembly
ECAT	Electronically Controlled Automatic Transaxle
ECM	Electronic Control Module
ECT	Engine Coolant Temperature Sensor
ECU	Electronic Control Unit or Engine Control Unit
EDF	Electric Drive Fan relay assembly
EDIS	Electronic Distributorless Ignition System
EEC	Electronic Engine Control
EECS	Evaporative Emission Control System
EEPROM	Electronically Erasable PROM
EFE	Early Fuel Evaporation
EFI	Electronic Fuel Injection
EGO	Exhaust Gas Oxygen sensor (see HEGO)
EGR	Exhaust Gas Recirculation system
EGRC	EGR Control solenoid or system
EGRV	EGR Vent solenoid or system
EMR	Emission Maintenance Reminder Module
ESA	Electronic Spark Advance
ESC	Electronic Spark Control
EST	Electronic Spark Timing
ETR	Emergency Tensioning Retractor
EVAP	Fuel Evaporative System
EVIC	Electronic Vehicle Information Center
EVO	Electronic Variable Orifice
EVP	EGR Valve Position Sensor
EVR	EGR Valve Regulator
EVRV	Electronic Vacuum Regulator Valve
Elect.	Electronic
Eng.	Engine
Evap.	Evaporative
Exc.	Except

## "F" ABBREVIATION TABLE

"F" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
° F	Fahrenheit (Degrees)
F/B	Fuse Block
FBC	Feedback Carburetor
FI	Fuel Injector or Fuel Injection
FICD	Fast Idle Control Device
FIPL	Fuel Injector Pump Lever
FP	Fuel Pump
FPM	Fuel Pump Monitor
FPR-VSV	Fuel Pressure Regulator Vacuum Switching Valve
FWD	Front Wheel Drive
Fed.	Federal
Ft. Lbs.	Foot Pounds

## "G" ABBREVIATION TABLE

"G" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
--------------	------------

g	grams
GND or GRND	Ground
GRN	Green
GRY	Gray
Ga.	Gauge
Gals.	gallons
Gov.	Governor

### "H" ABBREVIATION TABLE

"H" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
H/D	Heavy Duty
HAC	High Altitude Compensation
HC	Hydrocarbons
HEDF	High Speed Electro Drive Fan relay or circuit
HEGO	Heated Exhaust Gas Oxygen Sensor
HEGOG	HEGO Ground circuit
HEI	High Energy Ignition
HLDT	Headlight
HO	High Output
HP	High Performance
HSC	High Swirl Combustion
HSO	High Specific Output
HTR	Heater
HVAC	Heating
Headlt.	Headlight
Hg	Mercury
Hgt.	Height
Htr.	Heater
Hz	Hertz (Cycles Per Second)

### "I" ABBREVIATION TABLE

"I" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
I.D.	Inside Diameter
IAC	Idle Air Control
IACV	Idle Air Control Valve
IC	Integrated Circuit
ID	Identification
IDM	Ignition Diagnostic Monitor
IGN	Ignition system or circuit
ILC	Idle Load Compensator
In. Hg	Inches of Mercury
INCH Lbs.	Inch Pounds
INFL REST	Inflatable Restraint
INJ	Injector or Injection
IP	Instrument Panel
IPC	Instrument Panel Cluster
ISA	Idle Speed Actuator
ISC	Idle Speed Control
ISS	Idle Stop Solenoid
ITS	Idle Tracking Switch
IVSV	Idle Vacuum Switching Valve



Ign.	Ignition
In.	Inches
Inj.	Injector

## "J" ABBREVIATION TABLE

"J" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
J/B	Junction Block

## "K" ABBREVIATION TABLE

"K" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
k/ohms	1000 ohms (kilo as in k/ohms)
kg	Kilograms (weight)
kg/cm <sup>2</sup>	Kilograms Per Square Centimeter
KAM	Keep Alive Memory
KAPWR	Keep Alive Power
KM/H	Kilometers Per Hour
KOEO	Key On Engine Off
KOER	Key On Engine Running
KS	Knock Sensor

## "L" ABBREVIATION TABLE

"L" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
L	Liter(s)
L/D	Light Duty
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LH	Left Hand
LOS	Limited Operation Strategy
LT BLU	Light Blue
LT GRN	Light Green
LUS	Lock-Up Solenoid
Lbs.	Pounds
Lt (s) .	Light (s)
Lugg.	Luggage

## "M" ABBREVIATION TABLE

"M" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
mA	Milliamps
mV	Millivolts
mfd.	Microfarads

mm	Millimeters
M/T	Manual Transaxle or Transmission
MA PFI	Mass Air Sequential Port Fuel Injection system
MA or MAF	Mass Airflow
MAF	Mass Air Flow sensor
MAFS	Mass Airflow Sensor
MAP	Manifold Absolute Pressure sensor
MAT	Manifold Air Temperature
MCU	Microprocessor Control Unit
MCV	Mixture Control Valve
MEM-CAL	Memory Calibration Chip
MFI	Multiport Fuel Injection
MIL	Malfunction Indicator Light
MLP	Manual Lever Position
MPFI	Multi Point Fuel Injection
MPH	Miles Per Hour
MPI	Multi-Point (Fuel) Injection
Man.	Manual
Mech.	Mechanical
Mem.	Memory
Mtr.	Motor

## "N" ABBREVIATION TABLE

"N" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
N.m	Newton-Meter
NA	Not Available
NDS	Neutral Drive Switch
NGS	Neutral Gear Switch
NOx	Oxides of Nitrogen
NPS	Neutral Pressure Switch
No.	Number
Nos.	Numbers

## "O" ABBREVIATION TABLE

"O" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
O	Oxygen
O.D.	Outside Diameter
O/S	Oversize
O2	Oxygen
OC	Oxidation Catalyst
OCC	Output Circuit Check
OD	Overdrive
ODO	Odometer
OHC	Overhead Camshaft
ORG	Orange
OSC	Output State Check
Opt.	Option or Optional
oz.	Ounce
ozs.	Ounces

## "P" ABBREVIATION TABLE

"P" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
"P"	Park
P/C	Printed Circuit
P/N	Park/Neutral
P/S	Power Steering
PAV	Pulse Air Valve
PC-SOL	Purge Control Solenoid
PCM	Powertrain Control Module
PCS	Purge Control Solenoid
PCSDM	Passenger Compartment Sensor/Diagnostic Module
PCV	Positive Crankcase Ventilation
PFE	Pressure Feedback EGR sensor or circuit
PFI	Port Fuel Injection (see MA SEFI)
PGM-CARB	Programmed Carburetor
PGM-FI	Programmed Fuel Injection
PIP	Profile Ignition Pickup
PNK	Pink
PPL	Purple
PRNDL	Park Reverse Neutral Drive Low
PROM	Programmable Read-Only Memory
psi	Pounds Per Square Inch
PSPS	Power Steering Pressure Switch
PTC	Positive Temperature Coefficient
PTO	Power Take-Off
PWR GND	Power Ground circuit
Pkg.	Package
Press.	Pressure
Prog.	Programmed or Programmable
Pts.	Pints
Pwr.	Power

## "Q" ABBREVIATION TABLE

"Q" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
Qts.	Quarts

## "R" ABBREVIATION TABLE

"R" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
RABS	Rear Anti-Lock Brake System
RAC	Remote Accessory Control
RAM	Random Access Memory
RAP	Retained Accessory Power
RECIRC	Recirculation
RED	Red
RH	Right Hand
ROM	Read Only Memory
RPM	Revolutions Per Minute

RVB	Rear Vacuum Break
RWAL	Rear Wheel Anti-Lock Brake
RWD	Rear Wheel Drive
Recirc.	Recirculate or Recirculation
Reg.	Regulator
Rly.	Relay

## "S" ABBREVIATION TABLE

"S" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
SAW	Spark Angle Word
SBC	Single Bed Converter
SBEC	Single Board Engine Controller
SC	Super Charged
SCC	Spark Control Computer
SCS	Air Suction Control Solenoid
SDM	Supplemental Restraint System Diagnostic Module
SDU	SRS Diagnostic Unit
SEN	Sensor
SES	Service Engine Soon
SFI	Sequential (Port) Fuel Injection
SIG RTN	Signal Return circuit
SIL	Shift Indicator Light
SIR	Supplemental Inflatable Restraint
SMEC	Single Module Engine Controller
SOHC	Single Overhead Cam
SOL or Sol.	Solenoid
SPFI	Sequential Port Fuel Injection
SPK	Spark Control
SPOUT	Spark Output Signal
SRS	Supplemental Restraint System (Air Bag)
SS 3/4-4/3	Shift Solenoid circuit
SSI	Solid State Ignition
STAR	Self-Test Automatic Readout
STI	Self Test Input circuit
STO	Self-Test Output
SUB-O2	Sub Oxygen Sensor
Sen. or Sens.	Sensor
Sol.	Solenoid
Sprchg.	Supercharger
Strg.	Steering
Susp.	Suspension
Sw.	Switch
Sys.	System

## "T" ABBREVIATION TABLE

"T" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
T.V.	Throttle Valve
TAB	Thermactor Air By-Pass
TAC	Thermostatic Air Cleaner
TAD	Thermactor Air Diverter
TAN	Tan
TBI	Throttle Body Injection

TCC	Torque Converter Clutch
TCCS	Toyota Computer Control System
TDC	Top Dead Center
TDCL	Total Diagnostic Communication Link
TFI	Thick Film Ignition system
TGS	Top Gear Switch (cancels SIL in top gear)
THERMAC	Thermostatic Air Cleaner
THS	Transmission Hydraulic Switch
TP/TPS	Throttle Position Sensor
TPI	Tuned Port Injection
TPS	Throttle Position Sensor/Switch
TS	Temperature Sensor
TSB	Technical Service Bulletin
TTS	Transmission Temperature Switch
TV	Thermovalve
TWC	Three-Way Catalyst
Temp.	Temperature
Trans.	Transaxle/Transmission

## "V" ABBREVIATION TABLE

"V" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
V	Valve
VAF	Vane Air Flow sensor or circuit
VAPS	Variable Assist Power Steering
VAT	Vane Air Temperature
VATS	Vehicle Anti-Theft System
VBATT	Vehicle Battery Voltage
VCC	Viscous Converter Clutch
VIN	Vehicle Identification Number
VIO	Violet
VLR	Volt Loop Reserve
VM	Vacuum Modulator
VM	Vane Meter
VOM	Volt-Ohmmeter (Analog)
VPWR	Vehicle Power supply voltage (10-14 volts)
VREF	Voltage Reference (ECA supplied reference voltage)
VRV	Vacuum Regulator Valve
VSC	Vehicle Speed Control sensor or signal
VSS	Vehicle Speed Sensor or signal
VSV	Vacuum Switching Valve
Vac.	Vacuum
Volt.	Voltage

## "W" ABBREVIATION TABLE

"W" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
W/	With
W/O	Without
WAC	WOT A/C Cut-off switch or circuit
WAC	Wide Open Throttle A/C Switch
WHT	White
WOT	Wide Open Throttle
YEL	Yellow



# A/C COMPRESSOR REFRIGERANT OIL CHECKING

1993 Jeep Cherokee

1993 GENERAL SERVICING  
Compressor Refrigerant Oil Checking

Chrysler Motors

## \* PLEASE READ THIS FIRST \*

NOTE: For compressor application, see COMPRESSOR APPLICATIONS & BODY DESIGNATIONS in this article. DO NOT exceed A/C system refrigerant oil capacity when servicing system. See REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS in this article.

## REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications in table differ, use label specifications.

REFRIGERANT OIL & REFRIGERANT CAPACITY TABLE (CARS)

Application	(1) Oil Ounces	Refrigerant Ounces
Chrysler Corp.		
All FWD Cars	(2) 7.3	32
Concorde, Intrepid & Vision	5.0	28
Laser & Talon	5.0	33

(1) - Total system capacity, unless otherwise noted.

(2) - With fixed displacement compressor. Use 8.7 ounces with variable displacement compressor.

REFRIGERANT OIL & REFRIGERANT CAPACITY TABLE (LIGHT TRUCKS & VANS)

Application	(1) Oil Ounces	Refrigerant Ounces
Chrysler Corp. (Except Jeep)		
Dakota	4.6	44
FWD Vans (2)		
With Rear Unit	13.4	50
Without Rear Unit	6.7	36
Pickup & Ramcharger	4.6	44
RWD Vans		
With Rear Unit	9.3	65
Without Rear Unit	7.3	45
Jeep		
Cherokee	4.6	38
Grand Cherokee (2)	8.0	28
Wrangler	4.6	32

(1) - Total system capacity, unless otherwise noted.

(2) - Models use R-134a refrigerant and PAG (ND8) Refrigerant Oil (Part No. 82300102).

(3) - Models with auxiliary unit may require additional refrigerant. See decal under hood for capacity.

- (4) - Series codes are determined by fifth character of VIN code.  
 (5) - Models use PAG Refrigerant Oil (Part No. 12345923) and R-134a refrigerant.

## COMPRESSOR APPLICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications differ, use label specifications.

COMPRESSOR APPLICATIONS TABLE (CARS)

Application	Compressor
Chrysler Corp.	
Concorde, Intrepid, Laser, Talon & Vision .....	Nippondenso 10PA17 10-Cyl.
Except Concorde, Intrepid, Laser, Talon & Vision .....	Nippondenso 6C-17 6-Cyl., Nippondenso 10PA17 10-Cyl., Sanden TR-105 10-Cyl., Sanden SD-709P 7-Cyl.

- (1) - Body codes are determined by fourth character of VIN code.

COMPRESSOR APPLICATIONS TABLE (LIGHT TRUCKS & VANS)

Application	Compressor
Chrysler Corp. (Except Jeep)	
Dakota, Pickup & Ramcharger .....	Sanden SD-709 7-Cyl.
FWD Vans .....	Nippondenso 10PA17 10-Cyl.
RWD Vans .....	Sanden TR-105 10-Cyl.
Jeep	
Cherokee & Wrangler .....	Sanden SD-709 7-Cyl.
Grand Cherokee .....	Nippondenso 10PA17 10-Cyl.

- (1) - Series codes are determined by fifth character of VIN code.

## BODY DESIGNATIONS

BODY DESIGNATIONS TABLE (CHRYSLER CORP. CARS)

Body Designation (1)	Model
"A" Body .....	Acclaim, LeBaron Sedan & Spirit
"C" Body .....	Dynasty & New Yorker
"G" Body .....	Daytona
"J" Body .....	LeBaron Convertible/Coupe
"LH" Body .....	Concorde, Intrepid & Vision
"P" Body .....	Shadow & Sundance
"S" Body .....	Laser & Talon
"Y" Body .....	Fifth Avenue & Imperial

- (1) - Body codes are determined by fifth character of VIN code.

BODY DESIGNATIONS TABLE (CHRYSLER CORP. LIGHT TRUCKS & VANS)



Model	Designation
Caravan .....	"D" & "K" Series
Dakota .....	"N" Series
Pickups (Full Size) .....	"D" & "W" Series
Ramcharger .....	"AD" & "AW" Series
Town & Country .....	"Y" Series
Vans (Full Size) .....	"B" Series
Voyager .....	"H" & "P" Series

## REFRIGERANT OILS

Only NEW, pure, moisture-free refrigerant oil should be used in A/C systems. This oil is highly refined with a very low moisture content. Oil container must be tightly closed when not in use, or moisture from air will be absorbed into refrigerant oil.

Refrigerant R-12 based systems use mineral oil, while R-134a systems use synthetic/Polyalkylene Glycol (PAG) oil. Using a mineral oil based lubricant with R-134a systems will result in A/C compressor failure due to lack of proper lubrication.

Use ONLY specified oil for the appropriate system and A/C compressor. Always check the underhood A/C specification label or A/C compressor label before adding refrigerant oil to A/C compressor/system. The following types of R-134a refrigerant oil are currently available.

Chrysler/Jeep/Eagle  
PAG (ND8) Refrigerant Oil (82300102)

NOTE: Synthetic/PAG oil absorbs moisture very rapidly, 2.3-5.6 percent by weight as compared to a mineral oil absorption rate of .005 percent by weight.

## SERVICING PRECAUTIONS

### DISCHARGING SYSTEM

If compressor has stem-type service valves, it can be isolated and removed without discharging entire system. Otherwise, discharge A/C system using approved refrigerant recovery/recycling equipment before loosening any fittings.

### DISCONNECTING LINES & FITTINGS

After system is discharged, carefully clean area around all fittings to be opened. Always use 2 wrenches when loosening or tightening fittings. Some refrigerant lines are connected with a coupling. Special tools may be required to disconnect lines. Cap all openings as soon as lines are removed. DO NOT remove caps until ready to connect lines and fittings.

NOTE: All R-134a based systems use 1/2-16 ACME threaded fittings. Ensure all replacement parts match the connections of the system being worked on.

### CONNECTING LINES & FITTINGS

Always use NEW gasket or "O" ring when connecting lines or fittings. Coat "O" ring with refrigerant oil, and ensure it is not

twisted during installation. To prevent damage to lines and fittings, always use 2 wrenches.

## PLACING SYSTEM IN OPERATION

After component service or replacement has been completed, evacuate system thoroughly with a vacuum pump. Charge system with proper amount of refrigerant. See REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS in this article. Perform leak test. After system has been leak tested, check system operation.

NOTE: A/C systems normally will not need additional refrigerant oil unless oil loss has occurred due to ruptured lines, leaking compressor seals, compressor overhaul or component replacement.

## CHECKING COMPRESSOR OIL

### NIPPONDENSO 6C-17 6-CYLINDER

1) Slowly discharge system using approved refrigerant recovery/recycling equipment. Disconnect refrigerant hoses at compressor. Remove compressor bolts and compressor.

2) Remove suction port on top of compressor, and drain oil. Add proper amount of refrigerant oil to compressor (total system capacity minus amount retained in components that have not been replaced). See 6C-17 COMPONENT REFRIGERANT OIL CAPACITIES table. See REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS in this article for total system capacity.

3) Install compressor. Evacuate and recharge A/C system. Perform leak test.

6C-17 COMPONENT REFRIGERANT OIL CAPACITIES TABLE

Component	Ounces
Condenser .....	1
Evaporator	
Front .....	2
Rear (If Equipped) .....	2
Receiver-Drier .....	1

### NIPPONDENSO 10PA17 10-CYLINDER

Chrysler Motors (Laser & Talon)

Add specified amount if components are replaced. See 10PA17 COMPONENT REFRIGERANT OIL CAPACITIES table.

Chrysler Motors (Except Laser & Talon)

1) Slowly discharge system using approved refrigerant recovery/recycling equipment. Disconnect refrigerant hoses at compressor. Remove compressor bolts and compressor.

2) Remove suction port on top of compressor, and drain oil. Add proper amount of refrigerant oil to compressor (total system capacity minus amount retained in components that have not been replaced). See 10PA17 COMPONENT REFRIGERANT OIL CAPACITIES table. See REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS in this article for total system capacity.

3) Install compressor. Evacuate and recharge A/C system. Perform leak test.

# 10PA17 COMPONENT REFRIGERANT OIL CAPACITIES TABLE

Component	Ounces
Laser & Talon	
Compressor .....	1
Condenser .....	2/3
Evaporator .....	1
Receiver-Drier .....	1/3
Refrigerant Lines .....	1/3
Except Laser & Talon	
Condenser .....	1
Evaporator	
Front .....	2
Rear (If Equipped) .....	2
Receiver-Drier .....	1

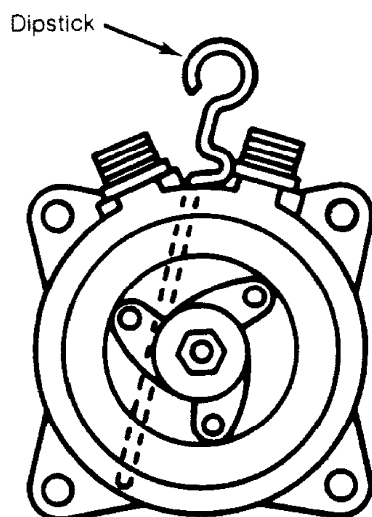
## SANDEN SD-709 & SD-709P 7-CYLINDER

1) Start and operate engine at high idle with A/C on for 15 minutes. Stop engine. Connect manifold gauge set to compressor service valves. Ensure valves on gauge set are closed. Place both valves on compressor in mid position. Start engine, and operate A/C.

2) Slowly turn compressor suction valve clockwise toward closed (front-seated) position. When suction pressure is reduced to zero, turn engine and compressor off, and quickly turn suction valve stem inward to full front-seated position. Turn discharge valve into front-seated position.

3) Loosen oil level plug to release internal pressure in compressor. Compressor is now isolated from rest of system, and service valves can be removed from compressor.

4) Remove compressor oil plug. Look through oil fill plug hole, and rotate compressor crankshaft to allow Dipstick (6465) to be fully inserted. Insert Dipstick (6465), and measure oil. See Fig. 1. Each mark on dipstick represents one increment.



17493  
Fig. 1: Checking Compressor Oil Level  
Courtesy of Sanden International U.S.A., Inc.

5) Place angle gauge across flat areas on mounting ears. Determine amount of oil needed based on mounting angle. See SD-709 &

SD-709P COMPRESSOR OIL INCREMENT CAPACITIES table.

6) If necessary, correct compressor oil level. Install compressor oil plug, and tighten it to 72-108 INCH lbs. (8-12 N.m). Evacuate and recharge A/C system. Perform leak test.

SD-709 & SD-709P COMPRESSOR OIL INCREMENT CAPACITIES TABLE

Mounting Angle	Oil Level (Increments)
0°	3-5
10°	4-6
20°	5-7
30°	6-8
40°	7-9
50°	8-10
60°	9-11
90°	10-12

## SANDEN TR-105 10-CYLINDER

1) Slowly discharge system using approved refrigerant recovery/recycling equipment. Disconnect refrigerant hoses at compressor. Remove compressor bolts and compressor.

2) Remove suction port on top of compressor, and drain oil. When repairing A/C systems with excessive leak(s), add additional oil.

3) Add proper amount of refrigerant oil to compressor (total system capacity minus amount retained in components that have not been replaced). See TR-105 COMPONENT REFRIGERANT OIL CAPACITIES table. See REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS in this article for total system capacity.

4) Install compressor. Evacuate and recharge A/C system. Perform leak test.

TR-105 COMPONENT REFRIGERANT OIL CAPACITIES TABLE

Component	Ounces
Condenser	1
Evaporator	
Front	2
Rear (If Equipped)	2
Receiver-Drier	1

# A/C COMPRESSOR OVERHAUL

1993 Jeep Cherokee

1993 GENERAL SERVICING  
Compressor Servicing

## REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications in table differ, use label specifications.

REFRIGERANT OIL & REFRIGERANT CAPACITY TABLE (CARS)

Application	(1) Oil Ounces	Refrigerant Ounces
Chrysler Corp.		
All FWD Cars .....	(2) 7.3 .....	32
Concorde, Intrepid & Vision .....	5.0 .....	28
Laser & Talon .....	5.0 .....	33

(1) - Total system capacity, unless otherwise noted.

(2) - With fixed displacement compressor. Use 8.7 ounces with variable displacement compressor.

REFRIGERANT OIL & REFRIGERANT CAPACITY TABLE (LIGHT TRUCKS/VANS)

Application	(1) Oil Ounces	Refrigerant Ounces
Chrysler Corp. (Except Jeep)		
Dakota .....	4.6 .....	44
FWD Vans (2)		
With Rear Unit .....	13.4 .....	50
Without Rear Unit .....	6.7 .....	36
Pickup & Ramcharger .....	4.6 .....	44
RWD Vans		
With Rear Unit .....	9.3 .....	65
Without Rear Unit .....	7.3 .....	45
Jeep		
Cherokee .....	4.6 .....	38
Grand Cherokee (2) .....	8.0 .....	28
Wrangler .....	4.6 .....	32

(1) - Total system capacity, unless otherwise noted.

(2) - Models use R-134a refrigerant and PAG (ND8) Refrigerant Oil (Part No. 82300102).

## COMPRESSOR APPLICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications differ, use label specifications.

COMPRESSOR APPLICATIONS TABLE (CARS)

Application	Compressor
Chrysler Corp.	
Concorde, Intrepid, Laser, Talon & Vision .....	Nippondenso 10PA17 10-Cyl.
Except Concorde, Intrepid, Laser, Talon & Vision .....	Nippondenso 6C-17 6-Cyl., Nippondenso 10PA17 10-Cyl., Sanden TR-105 10-Cyl., Sanden SD-709P 7-Cyl.

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#### COMPRESSOR APPLICATIONS TABLE (LIGHT TRUCKS & VANS)

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Application	Compressor
Chrysler Corp. (Except Jeep)	
Dakota, Pickup & Ramcharger .....	Sanden SD-709 7-Cyl.
FWD Vans .....	Nippondenso 10PA17 10-Cyl.
RWD Vans .....	Sanden TR-105 10-Cyl.

(1) - Series codes are determined by fifth character of VIN code.

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## BODY DESIGNATIONS

#### BODY DESIGNATIONS TABLE (CHRYSLER CORP. CARS)

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Body Designation (1)	Model
"A" Body .....	Acclaim, LeBaron Sedan & Spirit
"C" Body .....	Dynasty & New Yorker
"G" Body .....	Daytona
"J" Body .....	LeBaron Convertible/Coupe
"LH" Body .....	Concorde, Intrepid & Vision
"P" Body .....	Shadow & Sundance
"S" Body .....	Laser & Talon
"Y" Body .....	Fifth Avenue & Imperial

(1) - Body codes are determined by fifth character of VIN code.

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#### BODY DESIGNATIONS TABLE (CHRYSLER CORP. LIGHT TRUCKS & VANS)

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Model	Designation
Caravan .....	"D" & "K" Series
Dakota .....	"N" Series
Pickups (Full Size) .....	"D" & "W" Series
Ramcharger .....	"AD" & "AW" Series
Town & Country .....	"Y" Series
Vans (Full Size) .....	"B" Series
Voyager .....	"H" & "P" Series

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## NIPPONDENSO 6C-17 6-CYLINDER

### CLUTCH ASSEMBLY

#### Removal

- 1) Disconnect negative battery cable. Loosen and remove

compressor drive belt. Disconnect clutch coil lead. With refrigerant lines attached, remove compressor mounting bolts and position compressor for service.

2) Using Clutch Hub Holder (6355), remove crankshaft nut. Using Clutch Hub Puller (6354), remove clutch hub and hub clearance shims.

3) Remove snap ring and pulley assembly. Remove snap ring and clutch coil assembly.

#### Installation

1) Align hole in back of clutch coil with pin in compressor housing. Ensure clutch coil lead is properly routed. To complete installation, reverse removal procedure.

2) Tighten crankshaft nut. Using a feeler gauge, check clutch plate-to-pulley clearance. Clearance should be .020-.035" (.51-.89 mm). If clearance is incorrect, add or remove shims as necessary.

### SHAFT SEAL

#### Removal

1) Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Drain oil from compressor, and measure amount of oil drained. Remove compressor clutch assembly.

2) Remove compressor crankshaft key. Remove felt packing from nose of front cover. Clean area around seal.

3) Remove shaft seal snap ring. Using Seal Remover/Installer (6429), remove seal from compressor.

#### Installation

1) Lubricate NEW shaft seal with refrigerant oil. Install Seal Protector (6231) over compressor shaft. Using flat end of Seal Remover/Installer (6429), install shaft seal until seal seats in housing.

2) Install NEW shaft seal snap ring. Install clutch assembly. Using new refrigerant oil, add same amount of oil to compressor as was drained from it. Install compressor. Evacuate and recharge system. Perform leak test. See LEAK TESTING in A/C GENERAL SERVICING PROCEDURES article in the AIR CONDITIONING & HEAT Section.

### NIPPONDENSO 10PA17 & 10PA17A 10-CYLINDER

#### CLUTCH ASSEMBLY

##### Removal

1) Remove and discard compressor shaft bolt. Remove clutch plate and shims. Tap on clutch plate using a soft-faced hammer (if necessary).

2) Remove pulley assembly snap ring. Remove pulley assembly. Remove snap ring, and disconnect clutch coil lead. Remove clutch coil.

##### Installation (Chrysler)

1) Install clutch coil so pin in back of coil aligns with hole in front housing. Install snap ring with beveled side away from compressor.

2) Install pulley assembly. Install snap ring with beveled side away from compressor. If reusing original clutch plate and pulley, old shims can be used.

3) If using new components, install several shims so shim pack thickness is .10" (2.5 mm). Install clutch plate and hold it tightly against shims.

4) Using feeler gauge, measure air gap between clutch plate

and pulley surface. On Laser and Talon, clearance should be .014-.026" (.36-.66 mm). On all models except Laser and Talon, clearance should be .020-.035" (.51-.89 mm). Adjust shim thickness to obtain correct clearance. Install NEW compressor shaft bolt and tighten it to 13 ft. lbs. (18 N.m).

5) Once compressor shaft bolt is tightened, recheck clearance between clutch plate and pulley surface in 4 places. Readjust clearance if necessary.

NOTE: On Chrysler models, ensure voltage is correct after installing new clutch. Cycle clutch on for 5 seconds and off for 5 seconds. Repeat cycle 20 times with A/C on, blower fan on high speed and engine speed at 1500-2000 RPM.

## SHAFT SEAL

### Removal

1) Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Drain oil from compressor, and measure amount drained. Remove clutch assembly.

2) Remove felt dust seal and dust seal retainer from front head. See Fig. 1. Remove shaft seal snap ring. Position front head (nose up) on cardboard placed on a flat surface. Using brass drift, press shaft seal from front head.

### Installation

1) Lubricate new shaft seal with refrigerant oil. DO NOT touch sealing surfaces. Press seal into front head, and install snap ring. Install felt dust seal and dust seal retainer.

2) Lubricate Shaft Seal Protector (J-34614) and front head "O" ring with refrigerant oil. Install shaft seal protector on crankshaft. Install a new front head "O" ring on cylinder assembly.

3) Install front head on cylinder assembly. Ensure dowel pins are aligned. Use care when guiding shaft seal protector through seal opening. Remove shaft seal protector.

4) Install through bolts using NEW brass washers. Diagonally tighten bolts to 19 ft. lbs. (26 N.m). Using INCH-lb. torque wrench, check compressor shaft rotating torque. Rotating torque should be 26 INCH lbs. (3 N.m). Install clutch assembly.

5) Using new refrigerant oil, add same amount of oil to compressor as was drained from it. Install compressor. Evacuate and recharge system. Perform leak test. See LEAK TESTING in A/C GENERAL SERVICING PROCEDURES article in the AIR CONDITIONING & HEAT Section.



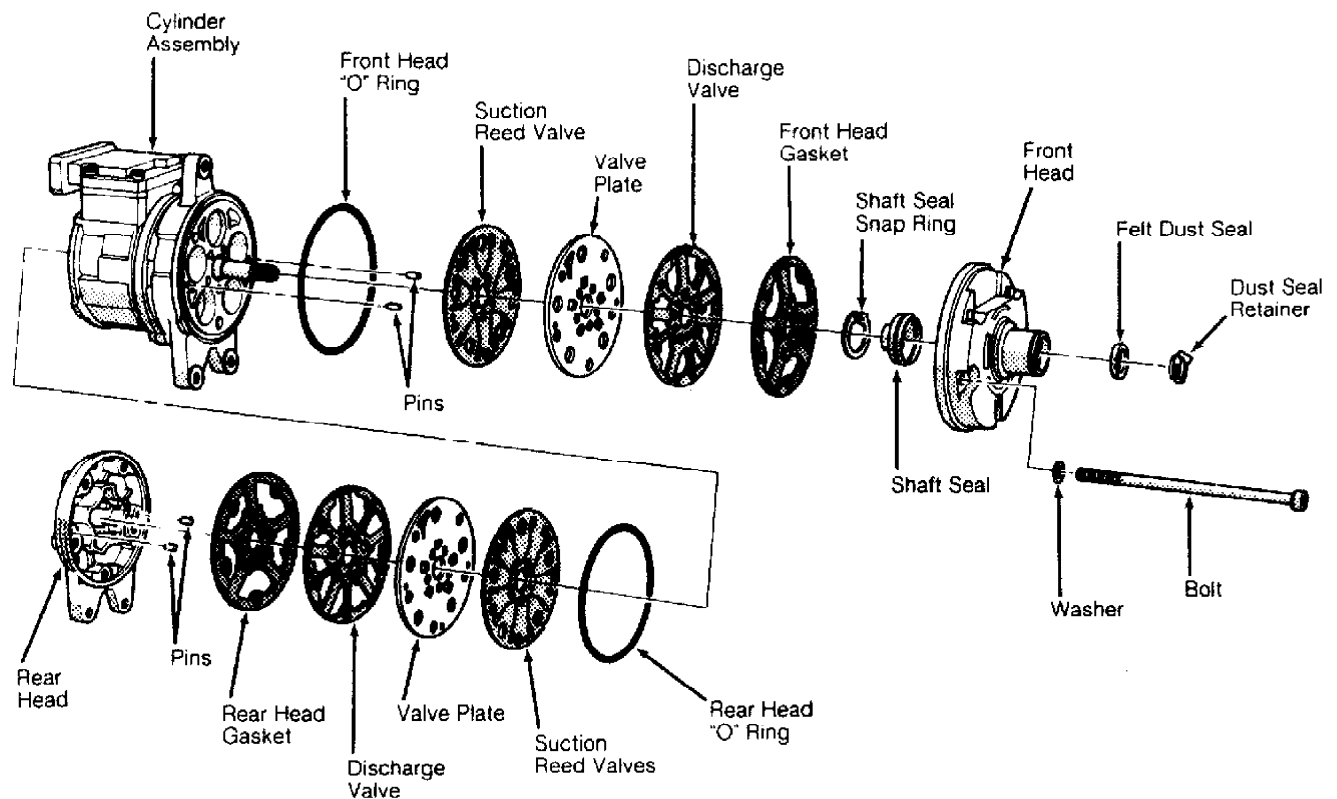


Fig. 1: Exploded View Of Compressor (Nippondenso 10PA17, 10PA17A & 10PA20 10-Cylinder)  
Courtesy of Ford Motor Co.

## SANDEN SD-709 & SD-709P 7-CYLINDER

### CLUTCH ASSEMBLY

#### Removal

1) Using Spanner (6462), hold clutch and remove compressor shaft nut. Using Puller (6461), remove clutch plate. Remove key from compressor shaft.

2) Remove pulley snap ring. Install jaws of Puller (6141-1) in snap ring groove on pulley. Place Shaft Protector (6141-2) on compressor shaft.

3) Install puller plate on jaws. Thread 2 bolts through puller plate into jaws. Remove pulley from compressor. Remove snap ring and clutch coil.

#### Installation

1) Install clutch coil and snap ring on compressor. Support compressor on rear mounting ears.

2) Using hammer, Handle (6464) and Driver (6143), install pulley assembly. Ensure driver rests on inner race of bearing when installing pulley assembly. Install snap ring.

3) Install shims. Install key in compressor shaft. Using hammer and Shaft Protector (6141-2), install clutch plate on compressor shaft. Tighten compressor shaft nut to 25-30 ft. lbs. (34-41 N.m).

4) Using feeler gauge, measure clearance between clutch plate and pulley assembly in several areas. Clearance should be .016-.031"

(.41-.79 mm). If clearance is not within specification, adjust shim thickness to obtain correct clearance.

## SHAFT SEAL

### Removal

- 1) Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Drain oil from compressor, and measure amount drained. Remove clutch assembly.
- 2) Remove key from shaft. Remove felt ring metal retainer and felt ring. Using small screwdriver, remove shims for clutch plate.
- 3) Ensure area around seal is clean. Remove shaft seal snap ring. Using Shaft Seal Remover/Installer (6142), remove shaft seal.
- 4) Install Shaft Seal Remover/Installer (6144) into shaft seal. Press downward on shaft seal remover/installer and rotate it to engage tangs with slots of shaft seal. Pull shaft seal from compressor.

### Installation

- 1) Install Shaft Protector (6141-2) over compressor shaft. Coat shaft protector, new shaft seal and shaft seal seat with refrigerant oil. DO NOT touch sealing surfaces of seal.
- 2) Place seal on seal remover/installer, and twist tool to hold seal. Install seal in compressor, and twist tool in opposite direction to release seal. Remove seal remover/installer. Using shaft seat remover/installer, install shaft seat.
- 3) Install snap ring. Tap on snap ring to ensure it seats in groove (if necessary). Install shims and new felt. To install remaining components, reverse removal procedure. Using new refrigerant oil, fill compressor with the same amount of oil drained from it. Install compressor. Evacuate and recharge system. Perform leak test. See LEAK TESTING in A/C GENERAL SERVICING PROCEDURES article in the AIR CONDITIONING & HEAT Section.

## SANDEN TR-105 10-CYLINDER

### CLUTCH ASSEMBLY

#### Removal

- 1) Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Install two 6-mm bolts in holes of clutch plate. Hold 6-mm bolts while removing nut from end of compressor shaft.
- 2) Remove clutch plate and shims. Tap clutch plate from compressor (if necessary). DO NOT pry between clutch plate and pulley to remove clutch plate.
- 3) Remove pulley assembly snap ring. Remove pulley assembly. Disconnect clutch coil lead. Scribe marks on clutch coil and compressor for installation reference. Remove snap ring and clutch coil.

#### Installation

- 1) Install clutch coil on compressor so locating pin engages hole in clutch coil. Install snap ring with beveled side away from compressor.
- 2) Install pulley assembly. Install snap ring with beveled side away from compressor. If reusing original clutch plate and pulley, old shims can be used.
- 3) If new components are used, install several shims so shim pack thickness is .10" (2.5 mm). Install clutch plate and hold it tightly against shims.
- 4) Using feeler gauge, measure air gap between clutch plate

and pulley surface. Proper clearance is .013-.025" (.33-.64 mm). Adjust shim thickness to obtain correct clearance. Tighten compressor shaft nut to 13 ft. lbs. (18 N.m).

5) Once compressor shaft nut is tightened, recheck clearance between clutch plate and pulley surface in 4 places. Readjust clearance if necessary. Install compressor. Evacuate and recharge system. Perform leak test. See LEAK TESTING in A/C GENERAL SERVICING PROCEDURES article in the AIR CONDITIONING & HEAT Section.

NOTE: After installing new clutch, ensure voltage is correct. Cycle clutch on for 5 seconds and off for 5 seconds. Repeat cycle 20 times with A/C on, blower fan on high speed and engine speed at 1500-2000 RPM.

## SHAFT SEAL

### Removal

1) Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Install two 6-mm bolts in holes of clutch plate. Hold 6-mm bolts while removing nut from end of compressor shaft.

2) Remove clutch plate and shims. Tap clutch plate from compressor (if necessary). DO NOT pry between clutch plate and pulley to remove clutch plate.

3) Insert 2 jaws of Bearing Remover/Installer (6533) into bearing groove. Install retainer over jaws of bearing remover/installer.

4) Tighten pressure screw of bearing remover/installer against compressor shaft until bearing is removed.

5) Remove felt washer from compressor. Remove shaft seal snap ring. Engage Seal Remover/Installer (6551) in slots of seal case. Lift seal from compressor.

### Installation

1) Place Seal Sleeve Protector (6552) over compressor shaft. Coat seal sleeve protector and seal lip with refrigerant oil. Using seal remover/installer, install seal. Remove seal sleeve protector.

2) Install shaft seal snap ring. Install felt washer. Install bearing in pulley. Using hammer with jaws and retainer of bearing remover/installer, drive bearing into pulley.

3) If reusing original clutch plate and pulley, old shims can be used. If using new components, install several shims so shim pack thickness is .10" (2.5 mm). Install clutch plate and hold it tightly against shims.

4) Using feeler gauge, measure air gap between clutch plate and pulley surface. Proper clearance is .013-.025" (.33-.64 mm). Adjust shim thickness to obtain correct clearance. Tighten compressor shaft nut to 13 ft. lbs. (18 N.m).

5) Once compressor shaft nut is tightened, recheck clearance between clutch plate and pulley surface in 4 places. Readjust clearance if necessary.

# **\* A/C-HEATER SYSTEM UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

A/C-Heater System Motorist Assurance Program  
Standards For Automotive Repair

All Makes and Models

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

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## **MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards

are continually republished. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

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Washington, DC 20005  
Phone (202) 712-9042 Fax (202) 216-9646  
January 1999

## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience,

or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

NOTE: When a repair is required, the shop must refuse partial

service to the system in question, if the repair creates or continues an unsafe condition.

#### Reasons to Suggest Repair or Replacement

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

## HEATING, VENTILATION, AND AIR CONDITIONING

### SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

CAUTION: Before working on any air conditioning system, be sure to review current local, state, federal, and EPA regulations regarding charging, recycling, and disposal of refrigerant.

## ACCUMULATORS

### ACCUMULATOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Beyond vehicle manufacturer's service interval .....	3	..... Suggest replacement.
Dessicant at the end of its useful life (saturated with moisture) .....	1	.. Suggest repair or replacement.
Dessicant bag deteriorated .....	A	..... (1) Require replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Tubing connection leaking .....	A	.. Require repair or replacement.



(1) - Inspect system to determine effects of dessicant bag deterioration.

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## ACTUATORS (ELECTRICAL)

### ACTUATOR (ELECTRICAL) INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted, affecting performance ..	A .....	(1) Require repair or replacement.
Connector melted, not affecting performance ..	2 .....	(1) Suggest repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	A .....	(2) Require replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Out of adjustment .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	1 .....	(1) Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	1 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

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## ACTUATORS (VACUUM)

### ACTUATOR (VACUUM) INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of

				hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.	
Connector broken .....	A	..	Require repair or replacement.	
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.	
Connector melted, affecting performance ..	A	.....	(1) Require repair or replacement.	
Connector melted, not affecting performance ..	2	.....	(1) Suggest repair or replacement.	
Connector missing .....	C	.....	Require replacement.	
Inoperative .....	A	.....	(2) Require replacement.	
Leaking (vacuum) .....	A	..	Require repair or replacement.	
Linkage bent, affecting performance .....	A	...	Require repair or replacement of linkage.	
Linkage bent, not affecting performance ..	2	...	Suggest repair or replacement of linkage.	
Linkage binding, affecting performance .....	A	...	Require repair or replacement of linkage.	
Linkage binding, not affecting performance ..	1	...	Suggest repair or replacement of linkage.	
Linkage broken .....	A	...	Require repair or replacement of linkage.	
Linkage loose, affecting performance .....	A	...	Require repair or replacement of linkage.	
Linkage loose, not affecting performance ..	1	...	Suggest repair or replacement of linkage.	
Linkage missing .....	C	.....	Require replacement.	
Linkage noisy .....	2	..	Suggest repair or replacement.	
Missing .....	C	.....	Require replacement.	
Noisy .....	2	..	Suggest repair or replacement.	
Out of adjustment .....	A	..	Require repair or replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.

## AIR CONDITIONING FITTINGS

See

AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES.

## AIR CONDITIONING HOSES

See

AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES.

## AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES

AIR CONDITIONING METAL LINE, HOSE AND FITTING ASSEMBLY INSPECTION

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Condition	Code	Procedure
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Abrasion damage, affecting structural integrity .....	A	..	Require repair or replacement.
Abrasion damage, not affecting structural integrity .....	..	.....	No service suggested or required.
Application incorrect ...	B	.....	Require replacement.
Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Clamp corroded, not reusable .....	1	.....	Suggest replacement.
Connected incorrectly ...	A	.....	Require repair.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Corroded, not affecting structural integrity ...	..	.....	No service suggested or required.
Cracked .....	A	..	Require repair or replacement.
Fitting type incorrect (such as compression fitting) .....	B	.....	Require replacement.
Flange leaking .....	A	..	Require repair or replacement.
Insufficient clamping force, allowing hose to leak .....	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Melted .....	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Outer covering damaged to the extent that the inner fabric is visible .....	A	.....	Require replacement.
Protective sleeves damaged .....	2	.	Suggest replacement of sleeves.
Protective sleeves missing .....	C	.	Require replacement of sleeves.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Routed incorrectly .....	2	.....	Require repair.
Swollen .....	1	.....	Suggest replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Type incorrect .....	1	..	Suggest repair or replacement.

## AIR CONTROL DOORS

See PLENUMS.

## AIR DAMS (EXTERNAL)

### AIR DAM (EXTERNAL) INSPECTION

Condition	Code	Procedure
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Application incorrect, affecting air conditioning system performance .....	A	..	Require repair or replacement.
Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Bent, affecting air conditioning system performance .....	A	..	Require repair or replacement.
Blocked, affecting air conditioning system performance .....	A	..	Require repair or replacement.
Broken, affecting air conditioning system performance .....	A	..	Require repair or replacement.
Cracked, affecting air conditioning system performance .....	A	..	Require repair or replacement.
Loose, affecting air conditioning system performance .....	A	.....	Require repair.
Loose, not affecting air conditioning system performance .....	2	.....	Suggest repair.
Missing, affecting air conditioning system performance .....	C	.....	Require replacement.

## AIR DISTRIBUTION SYSTEM

See PLENUMS.

## BELTS

### BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B	(1) Further inspection required.
Cracked .....	1	Suggest replacement.
Frayed .....	1	Suggest replacement.
Missing .....	C	Require replacement.
Noisy .....	2	(2) Further inspection required.
Plies separated .....	A	Require replacement.
Serpentine belt routed incorrectly .....	B	Require repair.
Tension out of specification .....	B	Require adjustment or replacement.
Worn beyond adjustment range .....	B	Require replacement.

Worn so it contacts  
 bottom of pulley ..... A ..... Require replacement.

(1) - Determine cause of incorrect alignment and require repair.  
 (2) - Determine cause of noise and suggest repair.

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## BLEND DOORS

See PLENUMS.

## BLOWER FANS (BLOWER WHEEL OR SQUIRREL CAGE)

### BLOWER FAN (BLOWER WHEEL OR SQUIRREL CAGE) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Application incorrect ...	B ..	Require repair or replacement.
Broken .....	A .....	Require replacement.
Cracked .....	A .....	Require replacement.
Distorted .....	A .....	Require replacement.
Fins missing .....	C .....	Require replacement.
Hub separated .....	A .....	Require replacement.
Inoperative .....	A .....	(1) Require replacement.
Mounting loose .....	A ..	Require repair or replacement.
Noisy .....	2 .....	Suggest replacement.
Out of balance .....	A ..	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of  
 OEM specification.

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## BLOWER MOTORS

### BLOWER MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted, affecting performance ..	A .....	(1) Require repair or replacement.
Connector melted, not		

affecting performance ..	2	.....	(1) Suggest repair or replacement.
Connector missing .....	C	.....	Require replacement.
Current draw out of specification .....	B	..	Require repair or replacement.
Inoperative .....	A	.....	(2) Require replacement.
Missing .....	C	.....	Require replacement.
Motor speed insufficient .....	2	..	Suggest repair or replacement.
Noisy .....	2	.....	Suggest replacement.
Rotation incorrect for application .....	B	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Vibration .....	1	.....	Suggest replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

## BLOWER RESISTORS

### BLOWER RESISTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Conductor exposed .....	A	..... Require replacement.
Connector broken .....	A	.. Require repair or replacement.
Connector melted, affecting performance ..	A	..... (1) Require repair or replacement.
Connector melted, not affecting performance ..	1	..... (1) Suggest repair or replacement.

Connector missing .....	C	.....	Require replacement.
Inoperative .....	A	.....	(2) Require replacement.
Insulation overheated ...	A	.....	Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

## BLOWER SWITCHES

See SWITCHES.

## CABIN AIR FILTERS

### CABIN AIR FILTER INSPECTION

Condition	Code	Procedure
Air flow obstruction ....	A	..... Require cleaning or replacement.
Maintenance intervals ...	3	..... Suggest replacement.
Missing .....	C	..... Require replacement.

## CIRCUIT BREAKERS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

## COMPRESSOR CLUTCH ASSEMBLIES

### COMPRESSOR CLUTCH ASSEMBLY INSPECTION

Condition	Code	Procedure
Air gap incorrect .....	B	.. Require repair or replacement.
Bearing seized .....	A	.. Require replacement of bearing or assembly.
Bearing worn, affecting performance .....	A	.. Require replacement of bearing or assembly.
Coil shows signs of overheating .....	1	.... Suggest replacement of coil.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted,		

affecting performance ..	A	.....	(1) Require repair or replacement.
Connector melted, not affecting performance ..	2	.....	(1) Suggest repair or replacement.
Connector missing .....	C	.....	Require replacement.
Hub broken .....	A	.....	Require replacement.
Hub cracked .....	B	.....	Require replacement.
Hub loose on shaft .....	A	.....	Require replacement.
Hub scored, affecting performance .....	A	.....	Require replacement.
Hub warped, affecting performance .....	A	.....	Require replacement.
Inoperative .....	A	.....	(2) Require repair or replacement.
Noisy .....	2	..	Suggest repair or replacement.
Slips .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Will not disengage .....	A	..	Require repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

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## COMPRESSORS

### COMPRESSOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bracket bent, affecting performance .....	A	.. Require repair or replacement.
Bracket bent, not affecting performance ..	..	..... No service suggested or required.



Bracket broken, affecting performance .....	A	.....	Require replacement.
Bracket broken, not affecting performance ..	..	.....	No service suggested or required.
Bracket corroded, affecting performance ..	A	..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A	..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A	..	Require repair or replacement.
Bracket holes elongated, not affecting performance .....	..	.....	No service suggested or required.
Bracket loose, affecting performance .....	A	..	Require repair or replacement.
Bracket loose, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket missing .....	C	.....	Require replacement.
Housing broken, affecting performance .....	A	..	Require repair or replacement.
Housing broken, not affecting performance ..	..	.....	No service suggested or required.
Housing cracked, affecting performance .....	A	..	Require repair or replacement.
Housing cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Inoperative .....	A	.....	(1) Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Noisy .....	2	.....	(2) Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Tubing connection leaking .....	A	..	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

(2) - Compressor noise can also be caused by low oil level, state of charge, air contamination, or type of refrigerant.

## CONDENSER AIR SEALS

### CONDENSER AIR SEAL INSPECTION

Condition	Code	Procedure
Leaking .....	A	Require repair or replacement.
Missing .....	C	Require replacement.

## CONDENSER FAN MOTORS

See COOLING FAN MOTORS.

## CONDENSERS

### CONDENSER INSPECTION

Condition	Code	Procedure
Abrasion damage, affecting structural integrity ...	A ..	Require repair or replacement.
Abrasion damage, not affecting structural integrity .....	.. .....	No service suggested or required.
Air flow obstruction, affecting performance ..	A ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bent, affecting performance .....	A ..	Require repair or replacement.
Bent, not affecting performance .....	.. .....	No service suggested or required.
Bracket bent, affecting performance .....	A ..	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A .....	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A ..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A ..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A ..	Require repair or replacement.
Bracket holes elongated, not affecting performance .....	.. .....	No service suggested or required.
Bracket loose, affecting performance .....	A ..	Require repair or replacement.
Bracket loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket missing .....	C .....	Require replacement.
Corroded, affecting structural integrity ...	A .....	Require replacement.
Corroded, not affecting structural integrity ...	.. .....	No service suggested or

Fitting type incorrect (such as compression fitting) .....	B	.....	Require replacement.
Flange leaking .....	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Restricted internally ...	A	..	Require repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

required.

## CONNECTORS

See WIRING HARNESSES AND CONNECTORS.

## CONTROL CABLES

### CONTROL CABLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Binding .....	A	.. Require repair or replacement.
Bracket bent, affecting performance .....	A	.. Require repair or replacement.
Bracket bent, not affecting performance ..	..	..... No service suggested or required.
Bracket broken, affecting performance .....	A	..... Require replacement.
Bracket broken, not affecting performance ..	..	..... No service suggested or required.
Bracket corroded, affecting performance ..	A	.. Require repair or replacement.
Bracket corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Bracket cracked, affecting performance .....	A	.. Require repair or replacement.
Bracket cracked, not affecting performance ..	1	.. Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A	.. Require repair or replacement.
Bracket holes elongated, not affecting performance .....	..	..... No service suggested or required.
Bracket loose, affecting performance .....	A	.. Require repair or replacement.
Bracket loose, not affecting performance ..	1	.. Suggest repair or replacement.
Bracket missing .....	C	..... Require replacement.
Broken .....	A	.. Require repair or replacement.
Cracked .....	2	.. Suggest repair or replacement.

Disconnected .....	A	..	Require repair or replacement.
Kinked .....	2	..	Suggest repair or replacement.
Melted .....	A	.....	(1) Require repair or replacement.
Missing .....	C	.....	Require replacement.
Out of adjustment .....	B	.....	(2) Require repair or replacement.
Routed incorrectly .....	2	.....	Suggest repair.
Seized .....	A	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

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## CONTROL HEADS (FUNCTION SELECTORS)

### CONTROL HEAD (FUNCTION SELECTOR) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted, affecting performance ..	A	..... (1) Require repair or replacement.
Connector melted, not affecting performance ..	2	..... (1) Suggest repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	2	.... Suggest require replacement.
Leaking .....	A	.. Require repair or replacement.
Malfunctioning .....	A	..... (2) Require repair or replacement.
Melted, affecting performance .....	A	..... (1) Require repair or replacement.
Melted, not affecting performance .....	..	..... No service suggested or required.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.

Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Includes inoperative, intermittent operation, or failure to perform all functions.

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## CONTROL LINKAGES

### CONTROL LINKAGE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ..	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A .	Require repair or replacement of hardware.
Bent .....	A .	Require repair or replacement.
Binding .....	A .	Require repair or replacement.
Bracket bent, affecting performance .....	A .	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A .....	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A .	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 .	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A .	Require repair or replacement.
Bracket cracked, not affecting performance ..	1 .	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A .	Require repair or replacement.
Bracket holes elongated, not affecting performance .....	.. ..	No service suggested or required.
Bracket loose, affecting performance .....	A .	Require repair or replacement.
Bracket loose, not affecting performance ..	1 .	Suggest repair or replacement.
Bracket missing .....	C .....	Require replacement.
Broken .....	A .....	Require replacement.
Cracked .....	A .	Require repair or replacement.
Disconnected .....	A .	Require repair or replacement.

Missing .....	C .....	Require replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Out of adjustment .....	B .....	(1) Require repair or replacement.
Seized .....	A ..	Require repair or replacement.

(1) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

## CONTROL MODULES

NOTE: Includes, but not limited to: IRCM, Coolant Fan Control Module (CFCM), AC Controller, Amplifier, Programmers, Control Heads, Power Modules, etc.

### CONTROL MODULE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Code set (if applicable) .....	A .....	(1) Further inspection required.
Connector broken .....	A ..	Require repair or replacement.
Connector melted, affecting performance ..	A .....	(2) Require repair or replacement.
Connector melted, not affecting performance ..	2 .....	(2) Suggest repair or replacement.
Connector missing .....	A .....	Require repair.
Contaminated .....	A .....	(3) Require repair or replacement.
Inoperative .....	B .....	(4) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
- (2) - Determine cause and correct prior to repair or replacement of part.
- (3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement. Check for accepted cleaning procedure.
- (4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable.

## COOLANT

### COOLANT INSPECTION

Condition	Code	Procedure
Acidity (pH) incorrect ..	1 .....	Suggest correction or replacement.
Contaminated .....	B .....	(1) Require replacement or recycling. Further inspection required.
Level incorrect .....	B .....	(2) Require filling to proper level.
Maintenance intervals ...	3 .....	(3) Suggest replacement.
Mixture incorrect .....	B .....	Require correction or replacement.
Type incorrect .....	B .....	Require replacement.

- (1) - Determine source of contamination and require correction prior to coolant replacement.
- (2) - Determine source of incorrect level and suggest repair.
- (3) - The system should be drained and/or flushed and refilled with correct coolant according to OEM recommended service interval and procedures.

## COOLING FAN BLADES

### COOLING FAN BLADE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.

Bent .....	A .....	Require replacement.
Broken .....	A .....	Require replacement.
Cracked .....	A .....	Require replacement.
Loose .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.

## COOLING FAN CLUTCHES

NOTE: Some lateral movement, measured at the fan blade tip, may be normal.

### COOLING FAN CLUTCH INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bearing noisy .....	A .....	Require replacement.
Bearing worn .....	A .....	Require replacement.
Fastener loose .....	A ...	Require repair or replacement of fastener.
Inoperative .....	A .....	(1) Require replacement.
Leaking .....	1 .....	Suggest replacement.
Seized .....	A .....	Require replacement.
Slips (insufficient fan speed) .....	A .....	Require replacement.
Thermal control incorrect .....	B ..	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## COOLING FAN MOTORS

### COOLING FAN MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted, affecting performance ..	A .....	(1) Require repair or replacement.



Connector melted, not affecting performance ..	2	.....	(1) Suggest repair or replacement.
Connector missing .....	C	.....	Require replacement.
Hydraulic fan motor leaking .....	A	..	Require repair or replacement.
Inoperative .....	A	.....	(2) Require replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	.....	Suggest replacement.
Rotation incorrect for application .....	B	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Vibration .....	1	.....	Suggest replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

## EVAPORATOR DRAIN TUBES

### EVAPORATOR DRAIN TUBE INSPECTION

Condition	Code	Procedure
Disconnected .....	A	..... Require repair.
Leaking .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Restricted .....	A	.. Require repair or replacement.
Routed incorrectly .....	B	..... Require repair.

## EVAPORATOR PRESSURE REGULATORS (EPRS)

### EVAPORATOR PRESSURE REGULATOR (EPR) INSPECTION

Condition	Code	Procedure
Inoperative .....	A	..... (1) Require repair or replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.

## EVAPORATORS

### EVAPORATOR INSPECTION

Condition	Code	Procedure
Abrasion damage, affecting structural integrity ...	A ..	Require repair or replacement.
Abrasion damage, not affecting structural integrity .....	.. .....	No service suggested or required.
Air flow obstruction, affecting performance ..	A ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bracket bent, affecting performance .....	A ..	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A .....	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A ..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A ..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A ..	Require repair or replacement.
Bracket holes elongated, not affecting performance .....	.. ..	No service suggested or required.
Bracket loose, affecting performance .....	A ..	Require repair or replacement.
Bracket loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket missing .....	C .....	Require replacement.
Corroded, affecting structural integrity ...	A .....	Require replacement.
Corroded, not affecting structural integrity ...	.. ..	No service suggested or required.
Evaporator foam seal leaking .....	A .....	Require replacement.
Evaporator foam seal missing .....	C .....	Require replacement.
Fitting type incorrect		

(such as compression fitting) .....	B	.....	Require replacement.
Flange leaking .....	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Restricted internally ...	A	..	Require repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

## EXPANSION VALVES

### EXPANSION VALVE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Corroded internally .....	1	..... Suggest replacement.
Filter screen torn .....	A	.. Require replacement of screen.
Inoperative .....	A	..... (1) Require repair or replacement.
Leaking .....	A	..... Require replacement.
Restricted .....	A	.. Require repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
(1) - Expansion valve operation may be affected by capillary tube location, corrosion, and insulation tape. Inoperative includes intermittent operation.		

## FUNCTION SELECTORS

See CONTROL HEADS (FUNCTION SELECTORS).

## FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS

### FUSE, FUSIBLE LINK AND CIRCUIT BREAKER INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Blown .....	A	..... (1) Require replacement.
Corroded, affecting performance .....	A	.. Require repair or replacement.
Corroded, not affecting performance .....	2	.. Suggest repair or replacement.
Cracked, affecting performance .....	A	.. Require repair or replacement.
Cracked, not affecting performance .....	1	.. Suggest repair or replacement.
Inoperative .....	A	... (2) Require replacement.
Insulation damaged,		

conductors exposed .....	A	..	Require repair or replacement.
Insulation damaged, conductors not exposed ..	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Routed incorrectly .....	B	.....	Require repair.
Secured incorrectly .....	B	.....	Require repair.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to replacement  
of part.

(2) - Inoperative includes intermittent operation.

## FUSIBLE LINKS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

## GASKETS

### GASKET INSPECTION

Condition	Code	Procedure
Leaking .....	A	..... (1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and  
repair or replace as necessary.

## HEATER CASES

See PLENUMS.

## HEATER CONTROL VALVES

### HEATER CONTROL VALVE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement

				of hardware.
Binding .....	2	..	Suggest repair or replacement.	
Coolant leak .....	A	..	Require repair or replacement.	
Disconnected .....	A	..	Require repair or replacement.	
Malfunctioning .....	A	.....	(1) Require repair or replacement.	
Missing .....	C	.....	Require replacement.	
Restricted .....	A	..	Require repair or replacement.	
Seized .....	A	..	Require repair or replacement.	
Vacuum leak .....	A	..	Require repair or replacement.	

(1) - Includes inoperative, intermittent operation, or failure to perform all functions.

## HEATER CORES

### HEATER CORE INSPECTION

Condition	Code	Procedure
Air flow obstruction ....	A ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Connection leaking .....	A ..	Require repair or replacement.
Corroded .....	1 ..	Suggest repair or replacement.
Disconnected .....	A ..	Require repair or replacement.
Fins damaged, affecting performance .....	A ..	Require repair or replacement.
Fins damaged, not affecting performance ..	.. ..	..... No service suggested or required.
Internal restrictions, affecting performance ..	A ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.

## HEATER HOSES

### HEATER HOSE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Connected incorrectly ...	A .....	Require repair.
Corroded, not reusable ..	1 .....	Suggest replacement.
Cracked .....	A ..	Require repair or replacement.
Hard (brittle) .....	1 ..	Suggest repair or replacement.
Inner fabric (webbing) damaged .....	A .....	Require replacement.
Insufficient clamping force, allowing hose to leak .....	A ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Maintenance intervals ...	3 .....	Suggest replacement.

Melted .....	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Outer covering damaged ..	1	.....	Suggest replacement.
Outer covering damaged to the extent that the inner fabric is visible .....	A	.....	Require replacement.
Protective sleeves damaged .....	2	.	Suggest replacement of sleeves.
Protective sleeves missing .....	2	.	Suggest replacement of sleeves.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Restricted, not affecting performance .....	2	..	Suggest repair or replacement.
Routed incorrectly .....	2	.....	Suggest repair.
Safety clip missing .....	C	.....	Require replacement.
Spongy .....	1	..	Suggest repair or replacement.
Stripped .....	A	.....	Require replacement.
Surface cracks (dry-rotted) .....	1	..	Suggest repair or replacement.
Swollen .....	B	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Type incorrect .....	1	..	Suggest repair or replacement.

## HIGH PRESSURE RELIEF VALVES (HPRV)

### HIGH PRESSURE RELIEF VALVE (HPRV) INSPECTION

Condition	Code	Procedure
Inoperative .....	A	..... (1) Require repair or replacement.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## IDLERS

See TENSIONERS.

## IN-LINE FILTERS

### IN-LINE FILTER INSPECTION

Condition	Code	Procedure
Connection leaking .....	B	.. Require repair or replacement.
Leaking .....	A	.. Require repair or replacement.
Restricted .....	A	..... Require replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.

## METAL FITTINGS

See

AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES.

## METAL LINES

See

AIR CONDITIONING METAL LINES, HOSES AND FITTING ASSEMBLIES.

## MIX AND AIR CONTROL DOORS (BLEND DOORS)

See PLENUMS.

## O-RINGS

### O-RING INSPECTION

Condition	Code	Procedure
Leaking .....	A .....	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

## ORIFICE TUBES

### ORIFICE TUBE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Bypassing internally ....	A ..	Require repair or replacement.
Filter screen torn .....	A .....	Require replacement.
Installation incorrect ..	B .....	Require repair.
Restricted .....	A ..	Require repair or replacement.

## PILOT-OPERATED ABSOLUTES (POAS)

### PILOT-OPERATED ABSOLUTE (POA) INSPECTION

Condition	Code	Procedure
Connection damaged .....	B ..	Require repair or replacement.
Fitting damaged .....	B ..	Require repair or replacement.
Inoperative .....	A .....	(1) Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## PLENUMS

### PLENUM INSPECTION

Condition	Code	Procedure
Air control door binding .....	A ...	Require repair or replacement
Air control door broken .....	A ..	Require repair or replacement.
Air control door leaking .....	A ..	Require repair or replacement.
Air control door seized .....	A ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Cracked .....	2 ..	Suggest repair or replacement.
Drain hole restricted ...	A .....	Require repair.
Drain plugged .....	A .....	Require repair.
Duct disconnected .....	A ..	Require repair or replacement.
Duct leaking .....	A ..	Require repair or replacement.
Duct missing .....	C .....	Require replacement.
Duct restricted .....	A ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Noisy .....	2 .....	Suggest cleaning or repair.
Odor .....	2 .....	Suggest cleaning or repair.
Restricted .....	A ....	Require cleaning, repair, or replacement.

## PRESSURE CONTROL VALVES

See:

- \* EVAPORATOR PRESSURE REGULATORS (EPRS)
- \* HIGH PRESSURE RELIEF VALVES (HPRV)
- \* PILOT-OPERATED ABSOLUTES (POAS)
- \* SUCTION THROTTLING VALVES (STVS)
- \* VALVES IN RECEIVER (VIRS)

## PRESSURE SENSORS

See THERMISTORS AND PRESSURE SENSORS.

## PULLEYS

### PULLEY INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B ..	Require repair or replacement.
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not		



functioning .....	A	...	Require repair or replacement of hardware.
Bearing noisy .....	2	.....	Suggest replacement.
Bearing seized .....	A	..	Require repair or replacement.
Bearing worn .....	1	.....	Suggest replacement.
Cracked .....	A	.....	Require replacement.
Loose .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Pulley damaged, affecting belt life .....	A	.....	Require replacement.

## RADIATORS

### RADIATOR INSPECTION

Condition	Code	Procedure
Air flow obstruction ....	A	..... Require repair.
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	.. Require repair or replacement of hardware.
Connection leaking .....	A	.. Require repair or replacement.
Corroded .....	1	.. Suggest repair or replacement.
Drain inoperative .....	A	.. Require repair or replacement.
Fins damaged, affecting performance .....	A	.. Require repair or replacement.
Fins damaged, not affecting performance ..	..	..... No service suggested or required.
Internal oil cooler leaking .....	A	.. Require repair or replacement.
Internal restrictions ...	B	.. Require repair or replacement.
Leaking .....	A	.. Require repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	.. Require repair or replacement.
Tubes damaged, affecting performance .....	A	.. Require repair or replacement.
Tubes damaged, not affecting performance ..	..	..... No service suggested or required.

## RECEIVER-DRIERS

NOTE: For VIRs, see VALVES IN RECEIVER (VIRS).

### RECEIVER-DRIER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware		

missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Contaminated, affecting performance .....	A	.....	Require replacement.
Dessicant bag deteriorated .....	A	.....	(1) Require replacement. Further inspection required.
Dessicant at the end of its useful life (saturated with moisture) .....	1	..	Suggest repair or replacement.
Fusible plug leaking ....	A	....	Require replacement of plug.
Leaking .....	A	.....	Require replacement.
Pressure relief device leaking .....	A	.	Require replacement of pressure relief device.
Restricted .....	A	..	Require repair or replacement.
Sight glass no longer transparent .....	2	...	Suggest replacement of drier.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Tubing connection leaking .....	A	..	Require repair or replacement.

(1) - Inspect system to determine effects of dessicant bag deterioration.

## REFRIGERANT

NOTE: Refrigerants include any SNAP (Significant New Alternative Policy)-approved blends.

### REFRIGERANT INSPECTION

Condition	Code	Procedure
Contaminated (other than refrigerant blends) ....	B	..... Require service to remove contamination.
Different types of refrigerants in the same system (other than refrigerant blends) ....	B	..... Require repair.
Overcharged .....	B	..... Require repair.
Refrigerant type does not match fittings and label .....	B	..... Require repair.
Undercharged .....	B	..... Require repair.

## REFRIGERANT OIL

### REFRIGERANT OIL INSPECTION

Condition	Code	Procedure
Contaminated .....	1	.. Require repair or replacement.
Overfilled .....	B	..... Require repair.

Underfilled ..... B ..... Require repair.

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## RELAYS

### RELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Housing broken .....	A .....	Require replacement.
Housing cracked .....	2 .....	Suggest replacement.
Inoperative .....	A .....	(1) Require replacement.
Melted, affecting performance .....	A .....	(2) Require repair or replacement.
Melted, not affecting performance .....	2 .....	(2) Suggest repair or replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

(2) - Determine cause and correct prior to repair or replacement of part.

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## SEALS

### SEAL INSPECTION

Condition	Code	Procedure
Leaking .....	A .....	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

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## SERVICE PORTS

## SERVICE PORT INSPECTION

Condition	Code	Procedure
Application does not match refrigerant type .....	B .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Valve cap leaking .....	A ...	Require repair or replacement of cap.
Valve cap missing .....	C ....	Require replacement of valve cap.
Valve core sticking .....	B ..	Require repair or replacement.

## SPRING LOCK COUPLINGS

### SPRING LOCK COUPLING INSPECTION

Condition	Code	Procedure
Leaking .....	A .....	(1) Require repair or replacement.
(1) - Require inspection of mating and sealing surface and repair or replace as necessary.		

## SUCTION THROTTLING VALVES (STVS)

### SUCTION THROTTLING VALVE (STV) INSPECTION

Condition	Code	Procedure
Connection damaged .....	B ..	Require repair or replacement.
Fitting damaged .....	B ..	Require repair or replacement.
Inoperative .....	A .....	(1) Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
(1) - Inoperative includes intermittent operation or out of OEM specification.		

## SWITCHES (ELECTRICAL)

### SWITCH (ELECTRICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.

Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Binding, affecting performance .....	A	..	Require repair or replacement.
Binding, not affecting performance .....	2	..	Suggest repair or replacement.
Broken .....	A	..	Require repair or replacement.
Burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Burned, not affecting performance .....	2	.....	(1) Suggest repair or replacement.
Cracked, affecting performance .....	A	..	Require repair or replacement.
Cracked, not affecting performance .....	1	..	Suggest repair or replacement.
Malfunctioning .....	A	.....	(2) Require repair or replacement.
Melted, affecting performance .....	A	.....	(1) Require repair or replacement.
Melted, not affecting performance .....	2	.....	(1) Suggest repair or replacement.
Missing .....	C	.....	(3) Require replacement.
Out of adjustment .....	B	..	Require repair or replacement.
Pressure switch leaking ..	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Won't return .....	A	..	Require repair or replacement.
Worn .....	1	.....	Suggest replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Includes inoperative, intermittent operation, or failure to perform all functions.
- (3) - Missing includes high pressure cut-off switches not installed during a retrofit from R12 to R134a.

## TENSIONERS

### TENSIONER INSPECTION

Condition	Code	Procedure
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Alignment incorrect .....	B	..	Require repair or replacement.
Application incorrect ...	B	.....	Require replacement.
Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Bearing worn .....	1	.....	Suggest replacement.
Belt tension incorrect ..	B	...	Require adjustment or repair.
Bracket cracked .....	A	..	Require repair or replacement.
Housing cracked .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	.....	Suggest replacement.
Pulley damaged, affecting belt life .....	A	.....	Require replacement.
Seized .....	A	..	Require repair or replacement.

## THERMISTORS AND PRESSURE SENSORS

NOTE: Includes, but not limited to, In-Car Temperature, Ambient Air Temperature, Sun Load Sensor, etc.

### THERMISTOR AND PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Calibration incorrect ...	B	.. Require repair or replacement.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted, affecting performance ..	A	..... (1) Require repair or replacement.
Connector melted, not affecting performance ..	2	..... (1) Suggest repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	A	..... (2) Require repair or replacement.
Missing .....	C	..... Require replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ...	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.

Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.

## THERMOSTATS AND HOUSINGS

### THERMOSTAT AND HOUSING INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	Require replacement.
Attaching hardware broken .....	A	Require repair or replacement of hardware.
Attaching hardware corroded .....	A	Require repair or replacement of hardware.
Attaching hardware missing .....	C	Require replacement of hardware.
Attaching hardware not functioning .....	A	Require repair or replacement of hardware.
Cracked .....	A	Require replacement.
Housing corroded .....	1	Suggest replacement of housing.
Inoperative .....	A	(1) Require replacement.
Installation incorrect ..	B	Require repair or replacement.
Leaking .....	A	Require repair or replacement.
Thermostat missing .....	C	Require replacement of thermostat.
Threads damaged .....	A	Require repair or replacement.
Threads stripped (threads missing) .....	A	Require repair or replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.

## VACUUM HOSES AND TUBES

### VACUUM HOSE AND TUBE INSPECTION

Condition	Code	Procedure
Disconnected .....	A	Require repair.
Leaking .....	A	Require repair or replacement.
Melted .....	A	Require repair replacement.
Missing .....	C	Require replacement.
Oil-soaked (spongy) .....	1	Suggest replacement.
Restricted .....	A	Require repair or replacement.

Routing incorrect .....	B	.....	Require repair.
Surface cracks (dry-rotted) .....	1	.....	Suggest replacement.

## VACUUM RESERVOIRS

### VACUUM RESERVOIR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Check valve leaking internally .....	A	..... Require replacement.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Restricted .....	A	.. Require repair or replacement.

## VACUUM TUBES

See VACUUM HOSES AND TUBES.

## VALVES IN RECEIVER (VIRS)

### VALVE IN RECEIVER (VIR) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bracket bent, affecting performance .....	A	.. Require repair or replacement.
Bracket bent, not affecting performance ..	..	..... No service suggested or required.
Bracket broken, affecting performance .....	A	..... Require replacement.
Bracket broken, not affecting performance ..	..	..... No service suggested or required.
Bracket corroded, affecting performance ..	A	.. Require repair or replacement.
Bracket corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Bracket cracked, affecting performance .....	A	.. Require repair or replacement.



Bracket cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A	..	Require repair or replacement.
Bracket holes elongated, not affecting performance ..	.....	.....	No service suggested or required.
Bracket loose, affecting performance ..	A	..	Require repair or replacement.
Bracket loose, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket missing ..	C	.....	Require replacement.
Connection damaged ..	B	..	Require repair or replacement.
Contaminated, affecting performance ..	A	.....	Require replacement.
Corroded internally ..	1	.....	Suggest replacement.
Dessicant bag deteriorated ..	A	.....	(1) Require replacement. Further inspection required.
Dessicant at the end of its useful life (saturated with moisture) ..	1	..	Suggest repair or replacement.
Filter screen torn ..	A	..	Require replacement of screen.
Fitting damaged ..	B	..	Require repair or replacement.
Fusible plug leaking ....	A	....	Require replacement of plug.
Inoperative ..	A	.....	(2) Require repair or replacement.
Leaking ..	A	..	Require repair or replacement.
Pressure relief device leaking ..	A	.	Require replacement of pressure relief device.
Restricted ..	A	..	Require repair or replacement.
Sight glass no longer transparent ..	2	...	Suggest replacement of drier.
Threads damaged ..	A	..	Require repair or replacement.
Threads stripped (threads missing) ..	A	.....	Require replacement.
Tubing connection leaking ..	A	..	Require repair or replacement.
(1) - Inspect system to determine effects of dessicant bag deterioration.			
(2) - Inoperative includes intermittent operation or out of OEM specification.			

## WATER PUMPS (ELECTRIC AUXILIARY)

### WATER PUMP (ELECTRIC AUXILIARY) INSPECTION

Condition	Code	Procedure
Attaching hardware broken ..	A	... Require repair or replacement of hardware.
Attaching hardware missing ..	C	..... Require replacement of hardware.
Attaching hardware not functioning ..	A	... Require repair or replacement of hardware.

Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted, affecting performance ..	A	.....	(1) Require repair or replacement.
Connector melted, not affecting performance ..	2	.....	(1) Suggest repair or replacement.
Connector missing .....	C	.....	Require replacement.
Inoperative .....	A	.....	(2) Require replacement.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	.....	Suggest replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Vibration .....	1	..	Suggest replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.

## WIRING HARNESSES AND CONNECTORS

### WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	.. Require repair or replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Circuit open .....	A	.. Require repair or replacement.
Circuit resistance (voltage drop) out of		

specification .....	A	..	Require repair or replacement.
Circuit shorted .....	A	..	Require repair or replacement.
Connector melted, affecting performance ..	A	.....	(1) Require repair or replacement.
Connector melted, not affecting performance ..	2	.....	(1) Suggest repair or replacement.
Connector missing .....	C	.....	Require replacement.
Diode open .....	A	..	Require repair or replacement.
Diode shorted .....	A	..	Require repair or replacement.
Insulation damaged, conductors exposed .....	A	..	Require repair or replacement.
Insulation damaged, conductors not exposed .	1	.....	Suggest replacement.
Protective shield (conduit) melted .....	B	.....	(1) Require replacement.
Protective shield (conduit) missing .....	C	.....	Require replacement.
Routed incorrectly .....	B	.....	Require repair.
Secured incorrectly .....	B	.....	Require repair.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Voltage drop out of specification .....	A	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

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# A/C-HEATER SYSTEM - MANUAL

1993 Jeep Cherokee

1993 AIR CONDITIONING & HEAT  
Chrysler Motors Manual A/C-Heater Systems

Jeep; Cherokee & Wrangler

## A/C SYSTEMS SPECIFICATIONS

SPECIFICATIONS TABLE

Application	Specification
Compressor Type .....	Sanden SD-709 7-Cyl.
Compressor Belt Tension	
Serpentine Belt	
New .....	180-200 lbs. (82-91 kg)
Used .....	140-160 lbs. (64-73 kg)
System Oil Capacity .....	4.6 ozs.
Refrigerant (R-12) Capacity	
Cherokee .....	38.0 ozs.
Wrangler .....	32.0 ozs.
System Operating Pressures	
High Side .....	160-235 psi (11.2-16.5 kg/cm <sup>2</sup> )
Low Side .....	30-35 psi (2.1-2.5 kg/cm <sup>2</sup> )

## DESCRIPTION & OPERATION

### A/C-HEATER SYSTEM

#### Cherokee

The A/C clutch relay controls voltage supply to the compressor clutch. Electronic Control Unit (ECU) energizes the A/C clutch relay. ECU will not energize relay if evaporator temperature is too low, or if the refrigerant system pressure is too low.

ECU monitors evaporator temperature based upon the voltage reference it receives from the A/C sensor (evaporator thermistor) in the evaporator housing. ECU monitors refrigerant pressure through low pressure switch on receiver-drier. If refrigerant pressure is less than 28 psi (2.0 kg/cm<sup>2</sup>), the low pressure switch contacts open. ECU then stops compressor operation to prevent damaging the compressor.

NOTE: ECU may delay compressor clutch engagement for as many as 30 seconds.

#### Wrangler

The A/C clutch relay controls voltage supply to the compressor clutch. Electronic Control Unit (ECU) energizes the A/C clutch relay. ECU will not energize relay if evaporator temperature is too low, or if the refrigerant system pressure is too low.

If the switch contacts in the A/C thermostat are open (indicating evaporator temperature is too low), or if the low pressure switch contacts are open (indicating refrigerant system pressure is too low), the ECU will not energize the A/C clutch relay. A/C thermostat (temperature control thermostat) is in evaporator housing. Low pressure switch is on receiver-drier. System uses a 3-speed blower motor instead of a blower resistor.

## CONTROL PANEL

#### Cherokee

The mode control lever (upper lever) operates a vacuum switch on the back of the control panel. The vacuum switch controls vacuum to defroster, floor, panel and fresh/recirculated air vacuum motors, as well as a vacuum-actuated heater control valve (water valve). The heater control valve closes when vacuum is applied to it.

The A/C switch is closed when the lever is in any of the A/C modes (MAX, NORM or BI-LEVEL). The temperature control lever (lower lever) moves a cable that controls the position of the blend-air door in the heater case.

#### Wrangler

The mode control lever (upper lever) moves 2 cables, one for the vent doors and one for the defrost/floor duct door. Lever also operates a vacuum switch on back of control panel.

The vacuum switch allows or denies vacuum to the fresh air door vacuum motor. The temperature control lever (lower lever) moves a cable that controls the position of the blend-air door in the heater case.

NOTE: System does not use a heater control valve (water valve).  
Coolant always flows through the heater core.

## TROUBLE SHOOTING

### INSUFFICIENT OR NO COOL AIR

1) Check blower motor operation. If blower motor operates, go to next step. If blower motor does not operate, check fuse. If fuse is blown, replace fuse. If fuse is okay, apply battery voltage directly to blower motor. If blower motor does not operate, replace blower motor. If blower motor operates, replace blower switch or repair wire harness.

2) Ensure airflow is correct. If airflow is not correct, check for correct operation of air distribution doors and for obstructions in vent channels. If airflow is correct, ensure compressor clutch is operating and drive belt is tightened to specification. Go to step 4).

3) If compressor clutch does not operate, check for battery voltage at compressor clutch connector. If voltage is present, replace the clutch. If voltage is not present, perform COMPRESSOR CLUTCH CIRCUIT test under TESTING.

4) Check refrigerant system for proper charge. Evacuate and charge system if necessary. Check pressure switch and replace if necessary. Check A/C sensor (Cherokee) or A/C thermostat (Wrangler) and replace if necessary. Check expansion valve and replace if necessary.

## TESTING

### A/C CLUTCH RELAY

#### Cherokee

1) A/C clutch relay is in engine compartment, in power distribution center. With engine at idle and MAX or NORM position selected, check voltage at Dark Blue/White wire of relay connector.

2) If voltage is not present, check for open Dark Blue/White wire or blown fuse F6 in power distribution center. If voltage is present, ground the Dark Blue/Orange wire at relay. If clutch engages, relay is okay. If clutch does not engage, replace relay.

## BLOWER MOTOR

1) Using an ohmmeter, check resistance between blower motor housing and chassis ground. Zero ohms should be present. If resistance is zero, go to next step. If resistance is more than zero ohms, repair ground connection.

2) Disconnect blower motor connector. Apply battery voltage to blower motor connector. Replace motor if it does not operate smoothly at high speed.

## BLOWER MOTOR CIRCUIT

Wrangler

1) Turn ignition on. Check voltage at ignition switch side of fuse No. 12. If no voltage is present, repair open in Black/Orange wire between fuse No. 12 and ignition switch. If battery voltage is present, check voltage on other side of fuse.

2) If battery voltage is not present, replace fuse. If battery voltage is present, check voltage at White wire terminal of blower switch. If battery voltage is present, go to next step. If battery voltage is not present, repair open White wire circuit between fuse No. 12 and blower switch.

3) With blower switch in LO position, check voltage at Dark Blue wire terminal of blower switch connector. If battery voltage is not present, replace blower switch. If battery voltage is present, go to next step.

4) With blower switch in MED position, check voltage at Green wire terminal. If battery voltage is not present, replace blower switch. If battery voltage is present, go to next step.

5) With blower switch in HI position, check voltage at Orange wire terminal. If battery voltage is not present, replace blower switch. If battery voltage is present, go to next step.

6) Turn ignition off. Check resistance between blower motor housing and chassis ground. If resistance is not zero ohms, repair ground wire between blower motor and ground. If resistance is zero ohms, go to next step.

7) Turn ignition on. With blower switch in LO position, check voltage at Dark Blue wire terminal of blower motor connector. If battery voltage is present, go to next step. If battery voltage is not present, repair Dark Blue wire between blower switch and blower motor.

8) With blower switch in MED position, check voltage at Green wire terminal. If battery voltage is present, go to next step. If battery voltage is not present, repair Green wire between blower switch and blower motor.

9) With blower switch in HI position, check voltage at Orange wire terminal. If battery voltage is present, blower motor circuit is okay. If battery voltage is not present, repair Orange wire between blower switch and blower motor.

NOTE: If blower motor fails to operate, and battery voltage was present at Dark Blue, Green and Orange wires, replace blower motor.

## COMPRESSOR CLUTCH CIRCUIT

Cherokee

1) Apply battery voltage to compressor clutch connector terminal. If clutch engages, go to next step. If clutch does not engage, connect a jumper wire between clutch coil frame and chassis ground. If clutch engages, repair clutch coil ground circuit. If clutch does not engage, replace clutch coil.

2) Turn ignition and blower switch on. Set control lever to

MAX or NORM position. Check voltage at Light Green wire terminal of low pressure switch connector. If battery voltage is not present, repair circuit between low pressure switch and control panel.

3) If battery voltage is present, check voltage at Dark Blue/Orange wire terminal of low pressure switch connector. If battery voltage is present, go to next step. If battery voltage is not present, check refrigerant system charge. Recharge system if undercharged. If refrigerant system charge is okay, replace low pressure switch.

4) Start engine. Check voltage at Dark Blue/Black wire terminal of A/C clutch relay connector. If battery voltage is not present, check fuse No. 6 in engine compartment fuse block. Replace fuse if blown. If battery voltage is present, connect a jumper wire between ground and Dark Blue/Orange wire terminal of A/C clutch relay connector. If clutch does not engage, check wiring to ECU.

#### Wrangler

1) Apply battery voltage to compressor clutch connector terminal. If clutch engages, go to next step. If clutch does not engage, connect a jumper wire between clutch coil frame and chassis ground. If clutch engages, repair clutch coil ground circuit. If clutch does not engage, replace clutch coil.

2) Turn ignition and blower switch on. Set control lever to MAX position. Check voltage at Light Blue/Black wire terminal of low pressure switch connector. If battery voltage is not present, go to step 4). If battery voltage is present, check continuity between low pressure switch terminals.

3) If there is continuity, repair open Light Blue/Red wire circuit between low pressure switch and ECU. If there is no continuity, check refrigerant system charge. Recharge system if undercharged. If system charge is okay, replace low pressure switch.

NOTE: Both wire terminals at the A/C thermostat connector are Light Blue. It will be necessary to determine which wire is the circuit from the blower switch.

4) Check voltage at Light Blue wire terminal of A/C thermostat connector (wire that leads to A/C blower switch). See WIRING DIAGRAMS. If battery voltage is not present, repair open Light Blue wire circuit between A/C thermostat and blower switch.

5) If battery voltage is present, check voltage at other Light Blue wire of A/C thermostat. If battery voltage is not present, replace A/C thermostat. If battery voltage is present, repair open Light Blue/Black wire circuit between low pressure switch and A/C thermostat.

## REMOVAL & INSTALLATION

### A/C SENSOR

#### Removal & Installation (Cherokee)

Disconnect negative battery cable. Remove center console (if equipped). Remove lower instrument panel. Disconnect A/C sensor connector. See Fig. 1. Carefully remove A/C sensor and capillary tube from hole in housing. Avoid bending capillary tube. To install, reverse removal procedure.

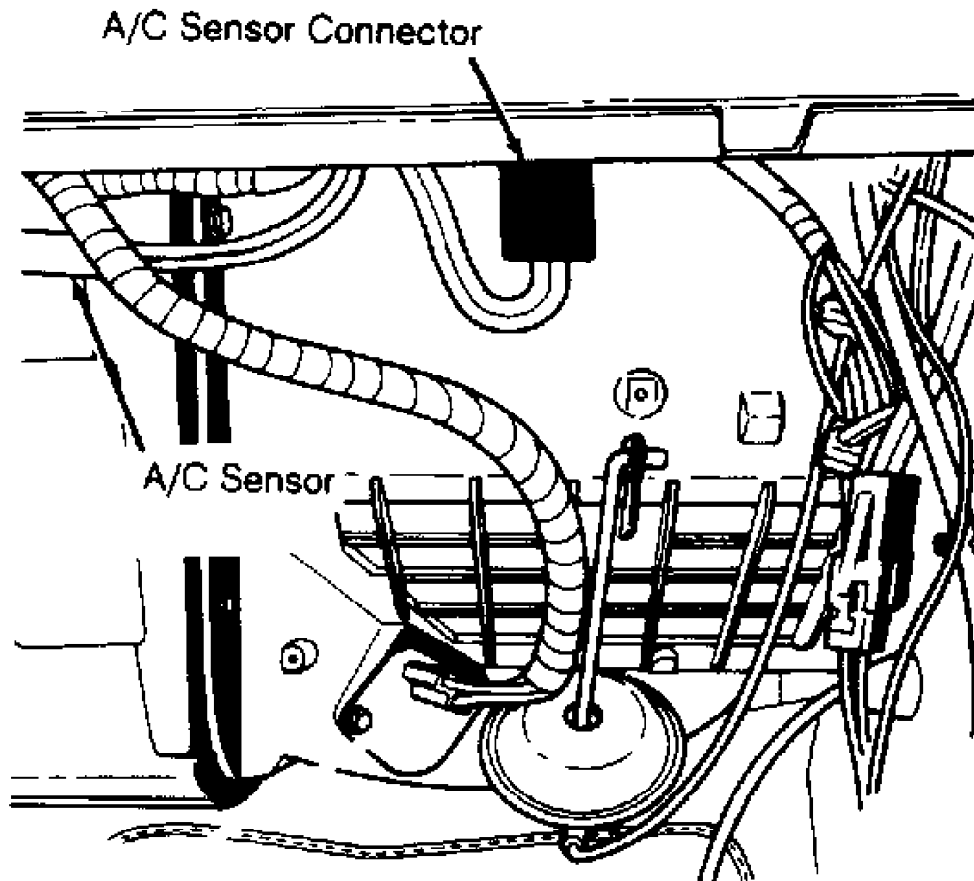


Fig. 1: Locating A/C Sensor (Cherokee)  
 Courtesy of Chrysler Corp.

## A/C THERMOSTAT

### Removal (Wrangler)

Remove evaporator housing. See EVAPORATOR & EVAPORATOR HOUSING under REMOVAL & INSTALLATION. Remove screws holding top and bottom halves of housing. Separate housing halves. Carefully remove A/C thermostat and capillary tube. Avoid bending capillary tube.

### Installation

Insert capillary tube into evaporator core at least 2" (51 mm), and about 2.5" (64 mm) from top of evaporator. See Fig. 2. Install thermostat. To complete installation, reverse removal procedure.



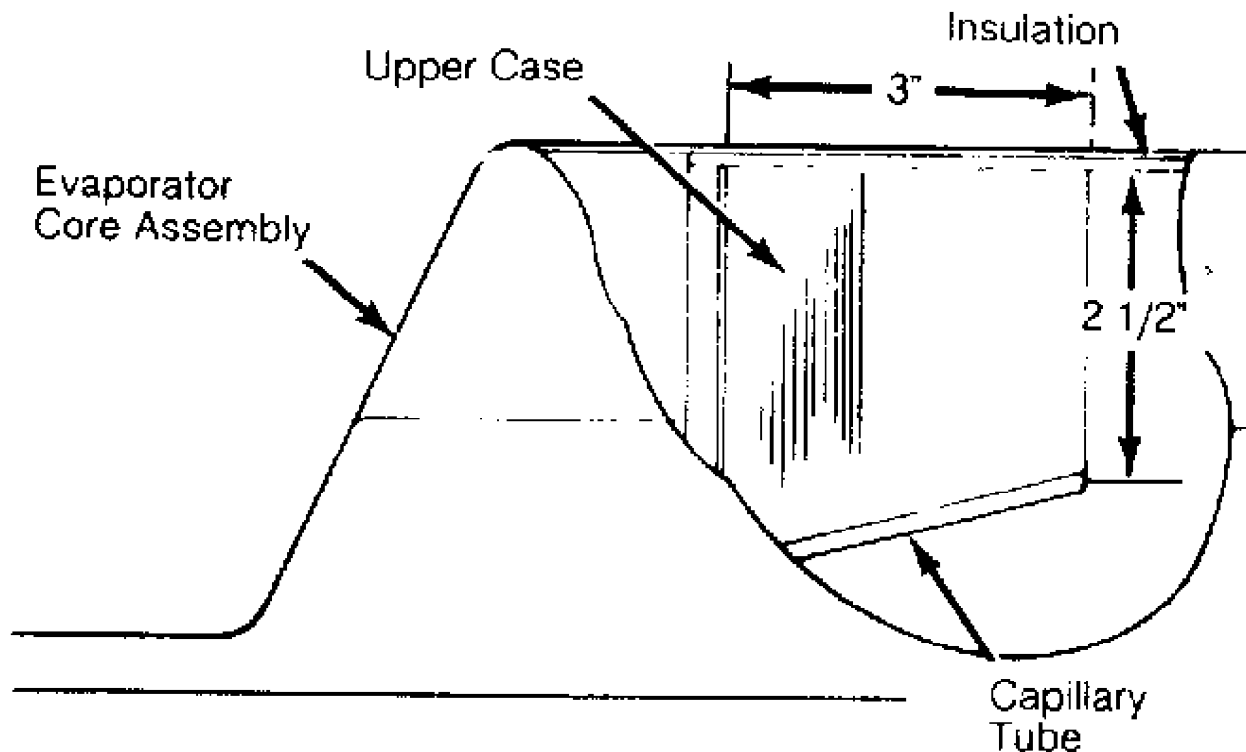


Fig. 2: Positioning Capillary Tube In Evaporator (Wrangler)  
(Cross-Sectional View Shown)  
Courtesy of Chrysler Corp.

## COMPRESSOR

**NOTE:** System charge can be retained by isolating compressor from rest of system. This eliminates the need to evacuate and recharge system after installation. To isolate compressor, begin removal procedure at step 1). If fully discharging system, begin at step 3).

### Removal

- 1) Connect service gauges. Close both valves on gauge. Set both service valves to mid-position. Start engine. Turn on A/C. Slowly turn low-side service valve clockwise toward front-seated position.
- 2) When low-side pressure is zero, stop the engine, turn off the A/C and quickly front-seat the low-side service valve. Front-seat the high-side service valve. Loosen the oil level check plug on the compressor to release any pressure in the compressor.
- 3) Disconnect negative battery cable. Disconnect clutch connector. Discharge A/C system using approved refrigerant recovery/recycling equipment (if compressor was not isolated).
- 4) With hoses attached to service valves, remove service valves from compressor. Remove drive belt. Remove compressor bolts and compressor.

#### Installation

1) To install, reverse removal procedure. If system was fully discharged, evacuate and charge system. If compressor was isolated before removal, air must be purged from compressor after service valve and hose assemblies are reconnected to compressor.

2) To purge air, cap the service gauge ports on both service valves. Turn low-side service valve counterclockwise until it stops (back-seated). This allows refrigerant to enter compressor. Set high-side service valve to mid-position.

3) Loosen gauge port cap on high-side service valve to allow refrigerant to purge air from the compressor. Back-seat high-side service valve, and then tighten gauge port cap. Air is now purged from compressor.

### CONDENSER

#### Removal (Cherokee - 2.5L)

1) Drain coolant from radiator. Disconnect fan shroud and radiator hoses. Disconnect automatic transmission cooler lines (if equipped). Discharge A/C system using approved refrigerant recovery/recycling equipment.

2) Disconnect refrigerant hoses from condenser. Disconnect low pressure switch connector from switch on receiver-drier. Remove radiator, condenser and receiver-drier as an assembly. Separate condenser from radiator. Remove receiver-drier from condenser.

#### Installation

To install, reverse removal procedure. Add one ounce of refrigerant oil to system if replacing condenser. Fill cooling system. Evacuate and charge system.

#### Removal & Installation (Cherokee - 4.0L)

1) Remove cooling fan shroud and cooling fan. Remove upper crossmember and bracket. Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect A/C hoses from condenser and plug openings. Disconnect and separate condenser from radiator. Remove condenser.

2) To install, reverse removal procedure. Add one ounce of refrigerant oil to system if replacing condenser. Fill cooling system. Evacuate and charge system.

#### Removal & Installation (Wrangler)

1) Discharge A/C system using approved refrigerant recovery/recycling equipment. Drain cooling system. Remove cooling fan shroud and radiator. Disconnect liquid line from condenser. Remove condenser screws. Tilt bottom of condenser toward engine.

2) From under vehicle, disconnect evaporator to receiver-drier hose from receiver-drier. Remove receiver-drier and condenser as an assembly. Remove receiver-drier from condenser. To install, reverse removal procedure. Fill cooling system. Evacuate and charge system.

### CONTROL PANEL

#### Removal & Installation

1) Disconnect negative battery cable. Remove screws from instrument panel bezel. Remove bezel. Remove radio (if equipped).

2) Remove control panel screws. Pull out control panel and disconnect vacuum hoses, wires and cables. Note locations for installation reference. Remove control panel. To install, reverse removal procedure.

### RECEIVER-DRIER

#### Removal & Installation (Cherokee)

On 2.5L, remove condenser and receiver-drier as an assembly. See CONDENSER under REMOVAL & INSTALLATION. On 4.0L, discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect low pressure switch connector. Remove receiver-drier. To install, reverse removal procedure. Evacuate and charge system.

#### Removal & Installation (Wrangler)

Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect refrigerant lines from receiver-drier. Remove receiver-drier. To install, reverse removal procedure. Evacuate and charge system.

### EVAPORATOR & EVAPORATOR HOUSING

#### Removal & Installation (Cherokee)

1) Disconnect negative battery cable. Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect blower motor connector and vent tube.

2) Remove console (if equipped). Remove lower instrument panel. Disconnect electrical connectors from blower motor resistor and A/C sensor. Disconnect vacuum hose at vacuum motor. Cut plastic strap holding evaporator housing to heater core housing.

3) Disconnect blend-air door control cable. Detach clip at rear of blower housing flange, and remove housing screws. Remove housing nuts from studs on engine compartment side of firewall. Remove evaporator drain tube.

4) Remove right kick panel. Remove instrument panel support bolt. Gently pull on right side of instrument panel, then rotate housing downward and toward rear of vehicle to disengage housing studs from firewall.

5) Remove evaporator housing. Disassemble evaporator housing and remove evaporator. To install, reverse removal procedure. Evacuate and charge system.

#### Removal & Installation (Wrangler)

1) Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect low-side refrigerant hose from compressor. Disconnect high-side refrigerant hose from receiver-drier.

2) Remove evaporator housing-to-instrument panel screws and bracket. Lower evaporator housing, and pull hoses and grommet through opening. See Fig. 3. Disassemble evaporator housing and remove evaporator. To install, reverse removal procedure. Evacuate and charge system.

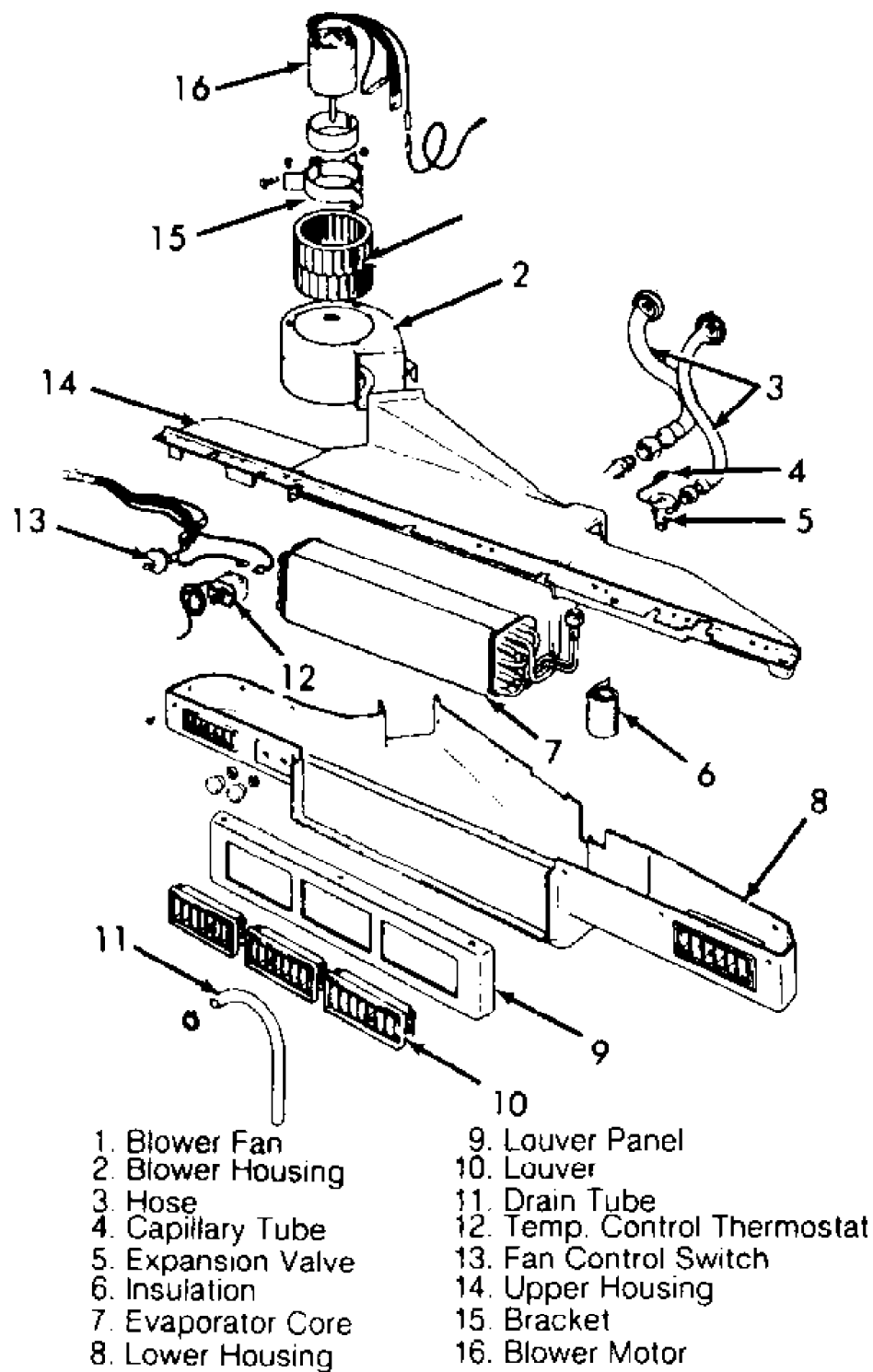


Fig. 3: Exploded View Of Evaporator Housing (Wrangler)  
 Courtesy of Chrysler Corp.

## EXPANSION VALVE

#### Removal & Installation (Cherokee)

Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove coolant reservoir and bracket. Disconnect refrigerant hoses from expansion valve. Disconnect expansion valve from evaporator tubes. Remove expansion valve. To install, reverse removal procedure. Evacuate and charge system.

#### Removal & Installation (Wrangler)

Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove evaporator housing. Remove insulation from expansion valve. See Fig. 3. Mark location of capillary tube on evaporator tubing. Disconnect refrigerant hose from expansion valve. Remove expansion valve. To install, reverse removal procedure. Evacuate and charge system.

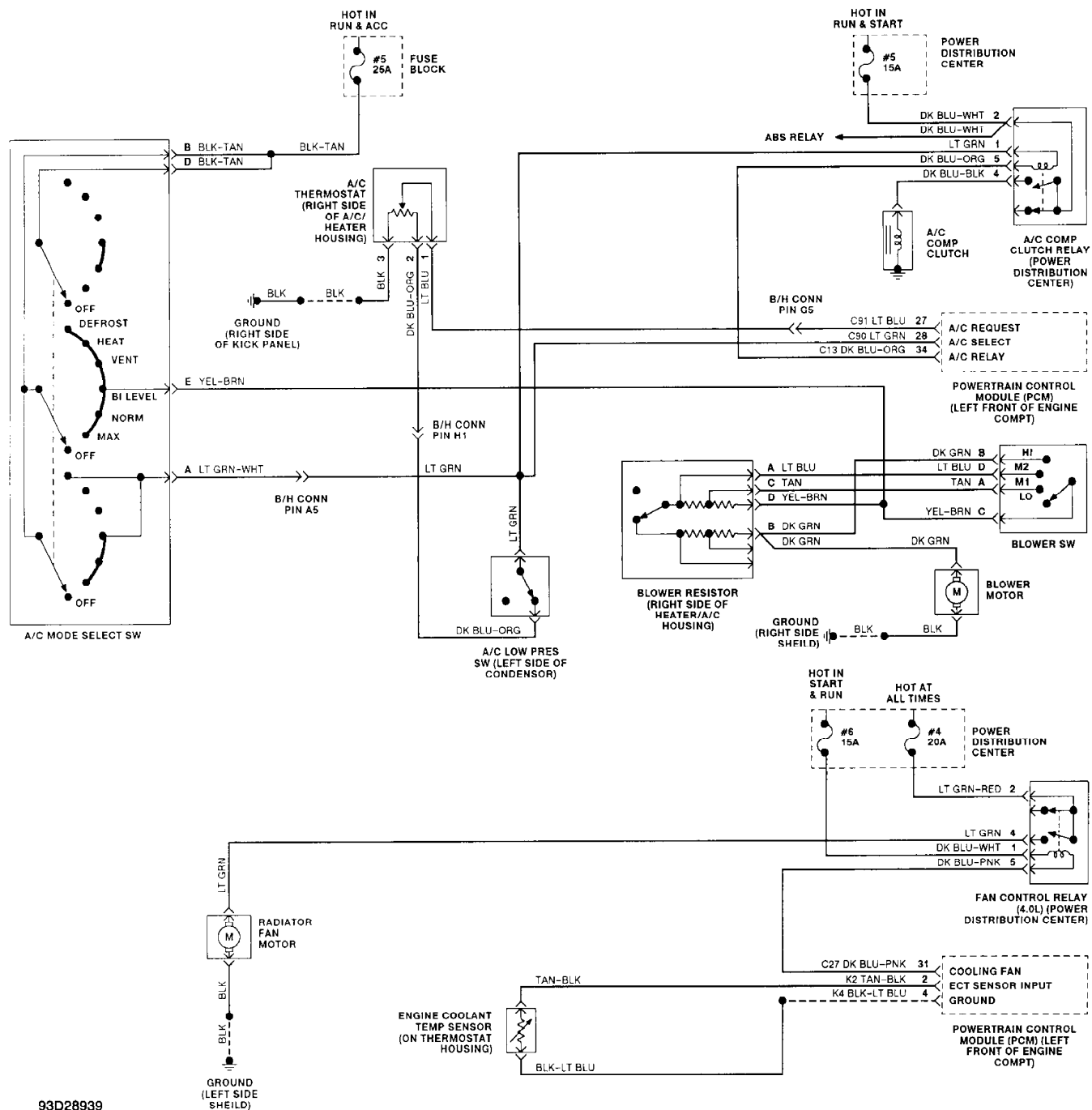
## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
A/C Compressor Bolt .....	20 (27)
Refrigerant Hoses	
Evaporator To Receiver-Drier .....	10 (14)
Expansion Valve To Evaporator .....	18 (24)
"O" Ring Fitting Type .....	24 (33)
Service Valve (Compressor Fitting) .....	(1) 25 (34)
Steering Column Nut .....	20 (27)

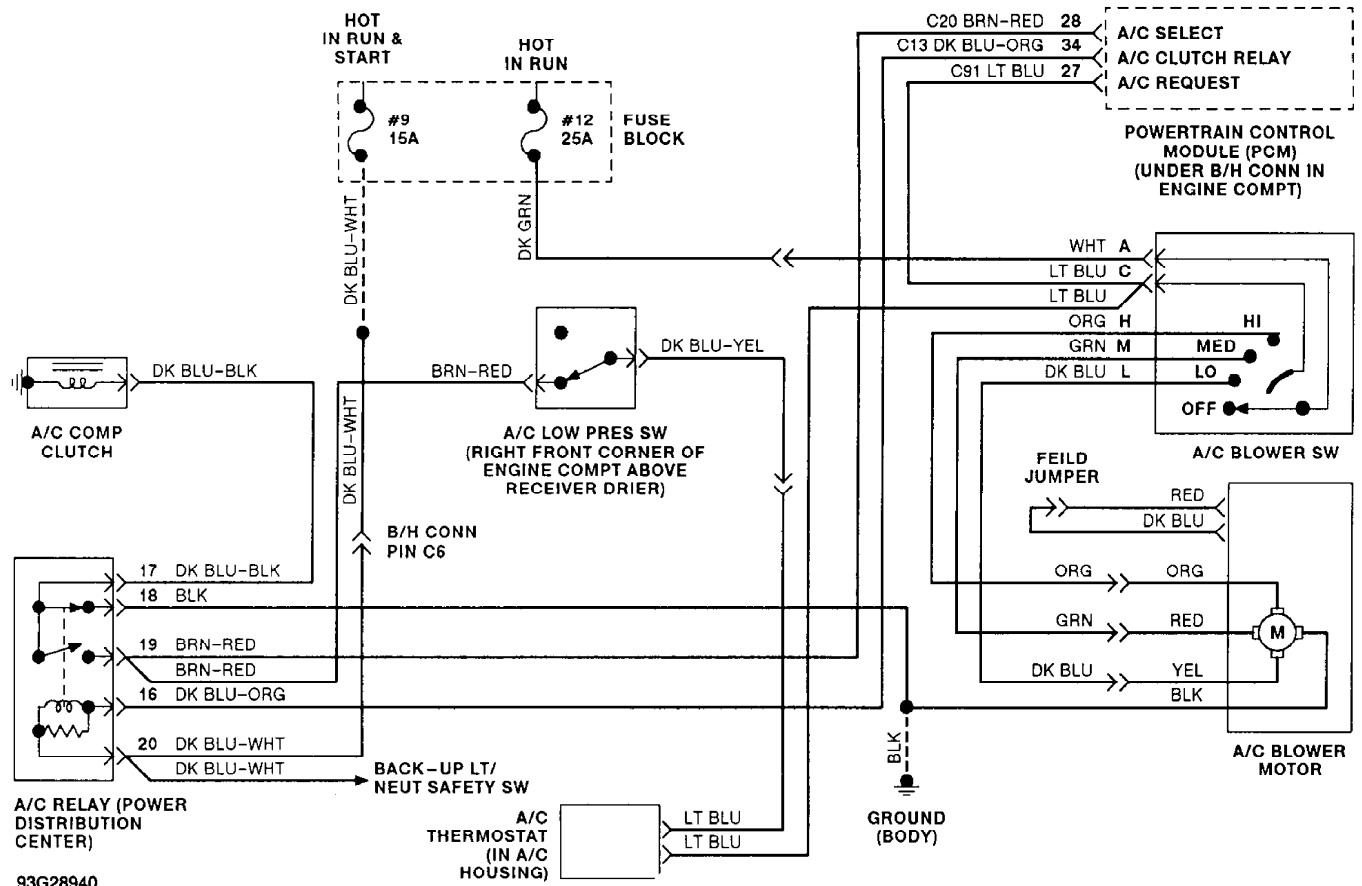
(1) - Lubricate threads and "O" ring with compressor oil.

## WIRING DIAGRAMS



93D28939

Fig. 4: Manual A/C-Heater System Wiring Diagram (Cherokee)



93G28940

Fig. 5: Manual A/C-Heater System Wiring Diagram (Wrangler)

# A/C SYSTEM SPECIFICATIONS

## 1993 Jeep Cherokee

1993 GENERAL SERVICING  
Applications & Oil/R-12 Capacities

Chrysler Motors

### COMPRESSOR APPLICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications differ, use label specifications.

#### COMPRESSOR APPLICATIONS TABLE (CARS)

Application	Compressor
Concorde, Intrepid, Laser, Talon & Vision .....	Nippondenso 10PA17 10-Cyl.
Except Concorde, Intrepid, Laser, Talon & Vision .....	Nippondenso 6C-17 6-Cyl., Nippondenso 10PA17 10-Cyl., Sanden TR-105 10-Cyl., Sanden SD-709P 7-Cyl.

#### COMPRESSOR APPLICATIONS TABLE (LIGHT TRUCKS & VANS)

Application	Compressor
Chrysler Corp. (Except Jeep) Dakota, Pickup & Ramcharger .....	Sanden SD-709 7-Cyl.
FWD Vans .....	Nippondenso 10PA17 10-Cyl.
RWD Vans .....	Sanden TR-105 10-Cyl.
Jeep Cherokee & Wrangler .....	Sanden SD-709 7-Cyl.
Grand Cherokee .....	Nippondenso 10PA17 10-Cyl.

### BODY DESIGNATIONS

#### BODY DESIGNATIONS TABLE (CARS)

Body Designation (1)	Model
"A" Body .....	Acclaim, LeBaron Sedan & Spirit
"C" Body .....	Dynasty & New Yorker
"G" Body .....	Daytona
"J" Body .....	LeBaron Convertible/Coupe
"LH" Body .....	Concorde, Intrepid & Vision
"P" Body .....	Shadow & Sundance
"S" Body .....	Laser & Talon
"Y" Body .....	Fifth Avenue & Imperial

(1) - Body codes are determined by fifth character of VIN code.

#### BODY DESIGNATIONS TABLE (LIGHT TRUCKS & VANS)



Model	Designation
Caravan .....	"D" & "K" Series
Dakota .....	"N" Series
Pickups (Full Size) .....	"D" & "W" Series
Ramcharger .....	"AD" & "AW" Series
Town & Country .....	"Y" Series
Vans (Full Size) .....	"B" Series
Voyager .....	"H" & "P" Series

## REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications in table differ, use label specifications.

REFRIGERANT OIL & REFRIGERANT CAPACITY TABLE (CARS)

Application	(1) Oil Ounces	Refrigerant Ounces
All FWD Cars .....	(2) 7.3 .....	32
Concorde, Intrepid & Vision .....	5.0 .....	28
Laser & Talon .....	5.0 .....	33

(1) - Total system capacity, unless otherwise noted.

(2) - With fixed displacement compressor. Use 8.7 ounces with variable displacement compressor.

REFRIGERANT OIL & REFRIGERANT CAPACITY TABLE (LIGHT TRUCKS/VANS)

Application	(1) Oil Ounces	Refrigerant Ounces
Chrysler Corp. (Except Jeep)		
Dakota .....	4.6 .....	44
FWD Vans (2)		
With Rear Unit .....	13.4 .....	50
Without Rear Unit .....	6.7 .....	36
Pickup & Ramcharger .....	4.6 .....	44
RWD Vans		
With Rear Unit .....	9.3 .....	65
Without Rear Unit .....	7.3 .....	45
Jeep		
Cherokee .....	4.6 .....	38
Grand Cherokee (2) .....	8.0 .....	28
Wrangler .....	4.6 .....	32

(1) - Total system capacity, unless otherwise noted.

(2) - Models use R-134a refrigerant and PAG (ND8) Refrigerant Oil (Part No. 82300102).

# A/C SYSTEM GENERAL SERVICING

## 1993 Jeep Cherokee

1993 GENERAL SERVICING  
General Servicing Procedures

Jeep

### USING R-12 & R-134a REFRIGERANT

#### HANDLING/SAFETY PRECAUTIONS

1) Always work in a well-ventilated, clean area. Refrigerant (R-12 or R-134a) is colorless and invisible as a gas. Refrigerant is heavier than oxygen and will displace oxygen in a confined area. Avoid breathing refrigerant vapors. Exposure may irritate eyes, nose and throat.

2) The system's high pressure can cause severe injury to eyes and skin if a hose were to burst. Always wear eye protection when working around A/C system and refrigerant. If necessary, wear rubber gloves or other protective clothing.

3) Refrigerant evaporates quickly when exposed to atmosphere, freezing anything it contacts. If liquid refrigerant contacts eyes or skin (frostbite), DO NOT rub eyes or skin. Immediately flush affected area with cool water for 15 minutes and consult a doctor or hospital.

4) Never use R-134a in combination with compressed air for leak testing. Pressurized R-134a in the presence of oxygen (air concentrations greater than 60 percent by volume) may form a combustible mixture. DO NOT introduce compressed air into R-134a containers (full or empty), A/C system components, or service equipment.

5) DO NOT expose A/C system components to high temperatures (steam cleaning for example) as excessive heat will cause refrigerant/system pressure to increase. Never expose refrigerant directly to open flame. If refrigerant needs to be warmed, place bottom of refrigerant tank in warm water. Water temperature MUST NOT exceed 125°F (52°C).

6) Use care when handling refrigerant containers. DO NOT drop, strike, puncture, or incinerate containers. Use Department Of Transportation (DOT) approved (DOT 4BW or DOT 4BA) refrigerant containers.

7) Never overfill refrigerant containers. The safe filling level of a refrigerant container MUST NOT exceed 60% of the container's gross weight rating. Store refrigerant containers below 125°F (52°C).

8) Freon (R-12) will be sold and stored in White colored containers, while R-134a refrigerant will be sold and stored in 30 or 50 pound Light Blue containers.

9) Refrigerant R-12 and R-134a must never be mixed, as they and their desiccants and lubricants are not compatible. If the refrigerants are mixed, system cross-contamination or A/C system component failure may occur. Always use separate servicing and refrigerant recovery/recycling equipment.

10) Read and follow equipment manufacturer's instructions for all service equipment to be used. The Material Safety Data Sheet (MSDS), provided by refrigerant manufacturer/suppliers, contains valuable information regarding the safe handling of R-12 or R-134a refrigerants.

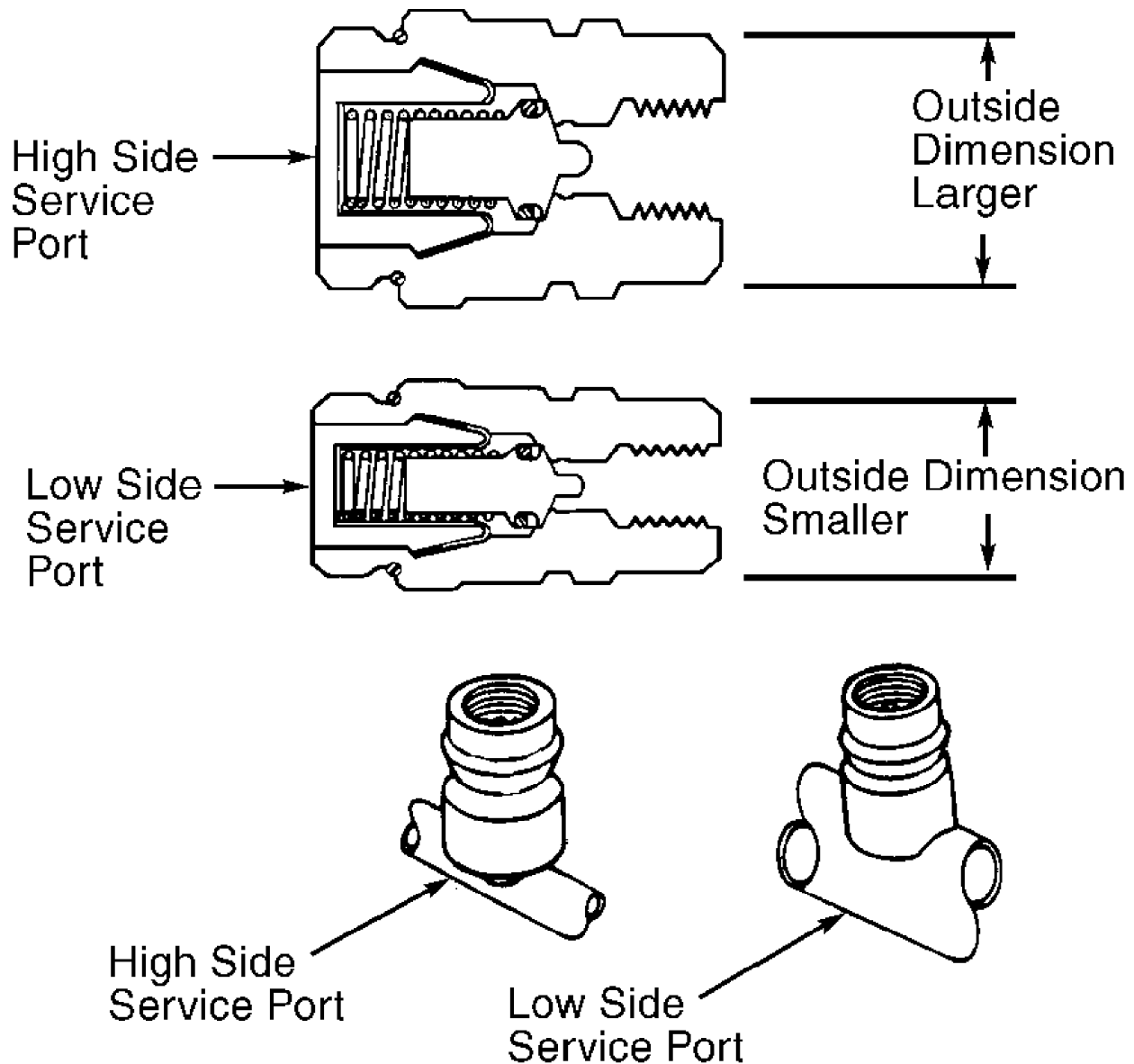
CAUTION: Keep work areas ventilated, and avoid operating engines near work area.

## IDENTIFYING R-134a SYSTEMS & COMPONENTS

To prevent refrigerant cross-contamination, use following methods to identify R-134a based systems and components.

### Fittings & "O" Rings

All R-134a based A/C systems use 1/2" - 16 ACME threaded fittings (identifiable by square threads) and quick-connect service couplings. See Fig. 1.









93|28488

Fig. 1: Identifying R-134a Service Couplings  
Courtesy of Chrysler Corp.

### Underhood A/C Specification Labels

Most R-134a based systems will be identified through the use

of underhood labels with R-134a refrigerant clearly printed on labels. See Fig. 2. The underhood label used on Ford Motor Co. vehicles is Yellow. Most manufacturers will identify refrigerant type with labels affixed to compressor. Before servicing an A/C system, always determine which refrigerant is being used.

 <b>CHRYSLER CORPORATION</b>		<b>53030452</b>	 <b>BRAKE FLUID</b>	<b>CAUTION</b> <b>R134a REFRIGERANT</b>
	<b>ENGINE OIL</b>			
	<b>ENGINE COOLANT</b>		<b>POWER STEERING FLUID</b>	<b>REFRIGERANT PART NO. 82300101</b> <b>LUBRICANT PART NO. 82300102</b> <b>RECOMMENDED CHARGE 0.8kg (28oz)</b> <b>AIR CONDITIONING SYSTEM</b> <b>(WHEN EQUIPPED) SHOULD ONLY BE</b> <b>SERVICED BY QUALIFIED PERSONNEL</b> <b>PER SERVICE MANUAL PROCEDURES.</b> <b>DO NOT USE R-12 REFRIGERANT.</b>
			<b>WINDSHIELD WASHER FLUID</b>	

**R-134a** A/C REFRIGERANT  
 FACTORY CHARGE 0.8kg(1.75lb)  
 SERVICE PART No. 82300101

**ND8 PAG** COMPRESSOR OIL  
 SERVICE PART No. 82300102

**WARNING: HIGH-PRESSURE REFRIGERANT SYSTEM**  
**TO BE SERVICED BY QUALIFIED PERSONNEL ONLY.**  
 CONSULT SERVICE MANUAL. IMPROPER SERVICE  
 METHODS MAY CAUSE PERSONAL INJURY. SYSTEM  
 MEETS SAFETY REQUIREMENTS OF SAE STANDARD J639



93D28483

Fig. 2: Underhood Refrigerant Identification Labels (Chrysler)  
 Courtesy of Chrysler Corp.

#### Other Means Of Identification

Refrigerant R-134a, when viewed through a sight glass, may have a "milky" appearance due to the mixture of refrigerant and lubricating oil. As the refrigerant and oil DO NOT exhibit a "clear" sight glass on a properly charged A/C system, most R-134a systems have no sight glass.

#### REFRIGERANT OILS

Refrigerant R-12 based systems use mineral oil, while R-134a systems use synthetic/Polyalkylene Glycol (PAG) oils. Using a mineral oil based lubricant with R-134a will result in A/C compressor failure due to lack of proper lubrication.

Use only specified oil for the appropriate system and A/C compressor. Always check the underhood A/C specification label or A/C compressor label before adding refrigerant oil to A/C compressor/system. See Fig. 2. The following R-134a refrigerant oils are currently available.

Jeep

Use PAG (ND8) Refrigerant Oil (Part No. 82300102).

NOTE: Synthetic/PAG oils absorb moisture very rapidly, 2.3–5.6% by weight, as compared to a mineral oil absorption rate of .005% by weight.

## SERVICE EQUIPMENT

NOTE: Ensure "O" rings are designed for use with specified refrigerant. Deterioration of "O" rings and system contamination will result if incorrect "O" rings are used.

Because R-134a is not interchangeable with R-12, separate sets of hoses, gauges and recovery/recycling equipment are required to service vehicles. This is necessary to avoid cross-contamination and damaging system.

All equipment used to service systems using R-134a must meet SAE standard J1991. The service hoses on the manifold gauge set must have manual (turn wheel) or automatic back-flow valves at the service port connector ends. This will prevent refrigerant from being released into the atmosphere.

For identification purposes, R-134a service hoses must have a Black stripe along their length and be clearly labeled SAE J2196/R-134a. The low pressure test hose is Blue with a Black stripe. The high pressure test hose is Red with a Black stripe. The center test hose is Yellow with a Black stripe.

NOTE: Refrigerant R-12 service hoses will ONLY be labeled SAE J2196.

R-134a manifold gauge sets can be identified by one or all of the following.

- \* Labeled FOR USE WITH R-134a on set
- \* Labeled HFC-134 or R-134a on gauge face
- \* Light Blue color on gauge face

In addition, pressure/temperature scales on R-134a gauge sets are different from R-12 manifold gauge sets.

## SIGHT GLASS INDICATOR

NOTE: Sight glass indicator conditions listed are for R-12 systems. Information for R-134a systems is not available from manufacturer.

Not all systems use a sight glass. If used, a sight glass may be mounted in receiver-drier (accumulator) or in discharge line. Refrigerant's condition can be visually checked while passing through sight glass. The following are possible conditions of sight glass indicator, which may help in the diagnosis of problems. See Fig. 3.

### Clear Sight Glass

A clear sight glass indicates refrigerant level is correct or is excessively low for system circulation. Sight glass may be clear, but system may contain excessive refrigerant. This must be verified by test gauge readings.

### Bubbly/Foamy Sight Glass

A bubbly or foamy sight glass indicates system is low on refrigerant, and air has probably entered system. However, if only occasional bubbles are noticed, during clutch cycling or system start-up, this may be a normal condition.

#### Oil Streaked Sight Glass

If oil streaks appear on sight glass, a lack of refrigerant may be indicated, and the system's compressor oil is circulating through the system.

#### Cloudy Sight Glass

A cloudy sight glass indicates desiccant contained in receiver-drier or accumulator has broken down and is being circulated through system.

Sight glass readings are not positive identification of a problem. Readings should be relied upon only when other system symptoms exist.

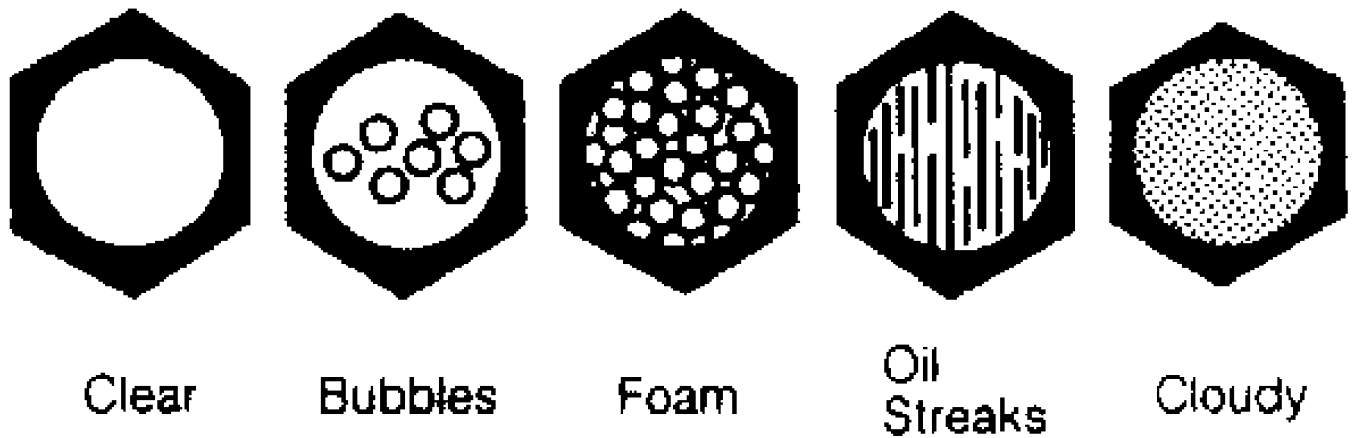


Fig. 3: Identifying Sight Glass Indicator Conditions

### SYSTEM SERVICE VALVES

#### STEM-TYPE VALVES

This manually operated service valve has adjustable stem located under a protective cap. Valve stem must be manually positioned when making gauge connections and/or reading system pressure on the gauges. See Fig. 4.

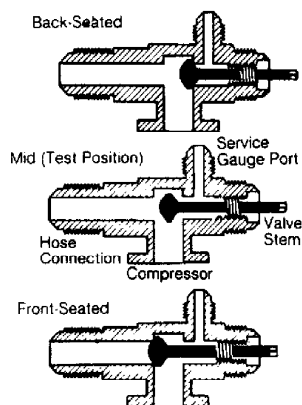


Fig. 4: Identifying Stem-Type Service Valve Positions

#### Back-Seated (Operating) Position

This is the normal operating position, which is also used for connecting and disconnecting manifold gauge set. Stem is turned fully

outward to seal the service gauge port.

#### Mid (Test) Position

After installing manifold gauge set (valve stem in back-seated position), turn valve stem 1 1/2 - 2 turns inward. This positions valve stem midway, allowing full system operation and permitting refrigerant pressure to reach gauges.

#### Front-Seated (Off) Position

With service valve stem turned inward, valve blocks refrigerant flow through system, isolating compressor for service.

CAUTION: NEVER operate A/C system with service valves in front-seated position, as the compressor will be damaged.

### SCHRADER-TYPE VALVES

NOTE: Although similar in construction and operation to a tire valve, NEVER replace a Schrader-type valve with a tire valve.

Schrader valve is similar in construction and operation to a tire valve. When a test gauge hose is attached (hose has built-in valve core depressor), Schrader stem is pushed inward to the open position and allows system pressure to reach the gauge.

If test hose being used does not have a built-in core depressor, an adapter must be used. Never attach hoses or adapters to a Schrader valve unless it is first connected to manifold gauge set.

### SERVICE VALVE LOCATIONS

For service valve locations, see SERVICE VALVE LOCATIONS (TRUCKS & VANS) table.

SERVICE VALVE LOCATIONS TABLE (TRUCKS & VANS)

Vehicle	High	Low
Jeep		
Cherokee & Wrangler .....	(1)	(1)
Grand Cherokee .....	(1)	(2)

(1) - On A/C compressor.

(2) - In suction line, near accumulator.

### SPECIAL VALVE CONNECTORS

All vehicles with R-134a refrigerant use quick-disconnect service valves. To help prevent installing hoses and other parts used on R-12 systems, all fittings on R-134a systems use 1/2"-16 ACME threads.

### MANIFOLD GAUGE SET

A manifold gauge set is used to determine system's high-side and low-side pressures, correct refrigerant charge, system diagnosis and operating efficiency. High (discharge) and low (suction) pressures must be compared to determine system operation. Manifold gauge sets for the two refrigerant types are basically the same. The fittings at the ends of the hoses are different to ensure connection only to a system using the type of refrigerant specified for that manifold gauge set.

#### Low-Side Gauge

The low-side gauge, which may have a Blue identifying feature, is used to measure low-side (suction) pressure. Low-side gauge is also called a compound gauge because it can measure pressure and vacuum. Pressure scale ranges from 0 to 150 psi; vacuum scale ranges from 0 to 30 in. Hg.

#### High-Side Gauge

The high-side gauge, which may have a Red identifying feature, is used to measure high-side (discharge) pressure. Gauge scale ranges from 0 to 500 psi.

### CONNECTING GAUGE SET

#### Schrader-Type Valves

1) Put on safety goggles, and cover vehicle's fender. Remove protective caps from Schrader valves. Do this slowly to check for leaky valves.

CAUTION: Ensure hand valves on manifold gauge set are closed before connecting test hoses to Schrader valves.

2) Ensure service hoses are equipped with valve core depressor to match Schrader valve. Special adapters are required if service hoses do not have built-in core depressor. Ensure both manifold gauge hand valves are closed.

3) Connect low-side service hose to low-side (suction) service valve, and finger tighten connections. Connect high-side service hose to high-side (discharge) service valve, and finger tighten connections.

#### Stem-Type Valves

1) Put on safety goggles, and cover vehicle's fender. Place valves in back-seated position. Remove protective caps from service valves. Do this slowly to check for leaky valves.

CAUTION: Ensure hand valves on manifold gauge set are closed before turning service valve to mid-position.

2) Attach low-side service hose to low-side (suction) service valve. Connect high-side service hose to high-side (discharge) service valve. Finger-tighten both connections.

NOTE: After test gauges are installed, test hoses must be purged of all air before proceeding with testing.

### PURGING TEST HOSES

1) Ensure high-side and low-side hoses are properly connected to service valves, and all hose connections are tight.

2) If stem-type service valves are used, turn stems inward  $1\frac{1}{2}$  - 2 turns to mid-position. On all applications, place clean shop towel over end of center service hose.

3) Purge high-side test hose by opening hand valve on high-side gauge for 3-5 seconds. This allows system's refrigerant to force air through test hoses and out of center service hose into the shop towel. Immediately close high-side gauge hand valve.

4) Purge low-side test hose in the same manner using hand valve of low-side gauge. Close hand valve after 3-5 seconds. Purging of test hoses is now complete, and system is ready for testing.

### STABILIZING A/C SYSTEM



1) Once manifold gauge set is attached to system and test hoses have been purged (if required), system is ready for testing. Place all test hoses, gauge set and other equipment away from all moving parts of engine.

2) Start engine, and turn A/C controls to maximum cooling position. Set blower fan on high speed. Open doors and/or windows, and operate system for 5-10 minutes. System should now be stabilized and ready for test readings.

## PRESSURE GAUGE INDICATIONS

**NOTE:** Pressure gauge indications are for R-12 systems only. Information for R-134a systems is not available from manufacturers.

The following typical pressure gauge indications represent conditions that may be encountered during system servicing. See Figs. 8-14. Temperature and humidity, as well as other factors, affect pressure gauge readings. Pressure gauge indications should be used only as a guide.

## EXCESSIVE MOISTURE GAUGE READINGS

Low Side Gauge - Normal-to-Low  
High Side Gauge - Normal

Other Symptoms

Sight Glass - Tiny bubbles.

Discharge Air - Becomes warm as low side cycles into vacuum. As moisture is released by saturated desiccant, it becomes released by saturated desiccant, it becomes trapped and freezes at expansion valve or orifice tube, blocking R-12 flow into the evaporator. As low side drops to a vacuum, high side may rise.

## EXCESSIVE MOISTURE

### GAUGE READINGS

Low Side Gauge - Normal-to-Low

High Side Gauge - Normal

### OTHER SYMPTOMS

Sight Glass - Tiny bubbles.

Discharge Air - Becomes warm as low side cycles into vacuum. As moisture is released by saturated desiccant, it becomes released by saturated desiccant, it becomes trapped and freezes at expansion valve or orifice tube, blocking R-12 flow into the evaporator. As low side drops to a vacuum, high side may rise.

### CORRECTION

- 1) Discharge refrigerant from system.
- 2) Replace receiver-drier, accumulator or desiccant bag.
- 3) Evacuate system with vacuum pump.
- 4) Charge system with R-12.
- 5) Operate system and check performance.

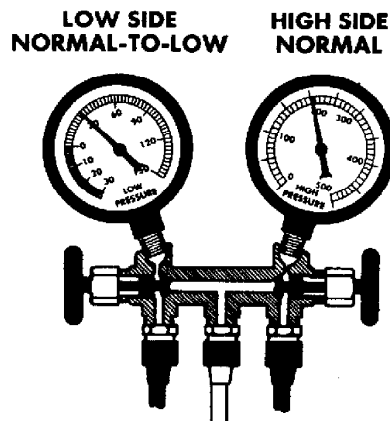


Fig. 5: Excessive Moisture Pressure Gauge Indications  
Courtesy of Ford Motor Co.

Correction

- 1) Discharge refrigerant from system.
- 2) Replace receiver-drier, accumulator or desiccant bag.
- 3) Evacuate system with vacuum pump.
- 4) Charge system with R-12.
- 5) Operate system and check performance.

## DEFECTIVE THERMOSTATIC SWITCH GAUGE READINGS

Low Side Gauge - Normal  
High Side Gauge - Normal

Other Symptoms

Compressor - Cycles on and off too fast.  
Low Side Gauge - Not enough range shown on low side gauge.

## DEFECTIVE THERMOSTATIC SWITCH

### GAUGE READINGS

Low Side Gauge - Normal

High Side Gauge - Normal

### OTHER SYMPTOMS

Compressor - Cycles on and off too fast.

Low Side Gauge - Not enough range shown on low side gauge.

### CORRECTION

- 1) Stop vehicle engine and turn air conditioner "OFF".
- 2) Remove and discard old clutch cycling switch, install a new switch of same type.
- 3) Operate system and check performance.

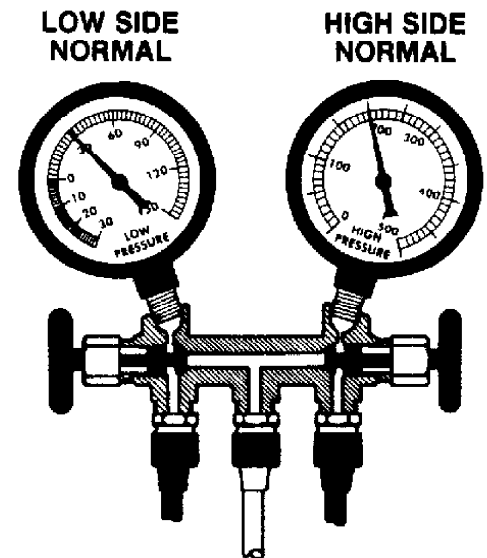


Fig. 6: Defective Thermostatic Switch Pressure Gauge Indications  
Courtesy of Ford Motor Co.

Correction

- 1) Stop vehicle engine and turn air conditioner "OFF".
- 2) Remove and discard old clutch cycling switch, install a new switch of same type.
- 3) Operate system and check performance.

## MISADJUSTED THERMOSTATIC SWITCH GAUGE READINGS

See DEFECTIVE CLUTCH CYCLING SWITCH PRESSURE GAUGE READINGS below.

## DEFECTIVE CLUTCH CYCLING SWITCH PRESSURE GAUGE READINGS

Low Side Gauge - Low-to-Normal/Normal-to-High  
High Side Gauge - Normal

Other Symptoms

Compressor - Cycles at incorrect temperature or pressure.

Evaporator - May freeze and restrict airflow if switch is allowing compressor to remain on too long.

## MISADJUSTED THERMOSTATIC SWITCH OR DEFECTIVE CLUTCH CYCLING SWITCH

### GAUGE READINGS

**Low Side Gauge** - Low-to-Normal/Normal-to-High

**High Side Gauge** - Normal

### OTHER SYMPTOMS

**Compressor** - Cycles at incorrect temperature or pressure.

**Evaporator** - May freeze and restrict airflow if switch is allowing compressor to remain on too long.

### CORRECTION

**With Thermostatic Switch**

- 1) Stop engine and turn air conditioner off.
- 2) Remove components necessary to gain access to thermostatic adjustment screw.

**NOTE:** If no adjusting screw is provided, the switch is nonadjustable and must be replaced.

- 3) Make certain that all wiring is positioned so that no short-circuiting can occur. Connect battery cable so that engine can be operated while making switch adjustment. Adjust thermostatic switch.

**With Clutch Cycling Switch**

- 1) Stop engine and turn air conditioner off.

**NOTE:** Switch is nonadjustable and is mounted on a Schrader valve fitting. Therefore, no system discharge is required.

- 2) Detach electrical connector from pressure sensing switch at accumulator.
- 3) Remove pressure sensing switch, and install a new switch.

**NOTE:** A pressure sensing switch is used on most late Ford Motor Co., General Motors and Eagle models with accumulator-type systems. It performs the same function as thermostatic switch.

**LOW SIDE  
LOW-TO-NORMAL  
NORMAL-TO-HIGH**

**HIGH SIDE  
NORMAL**

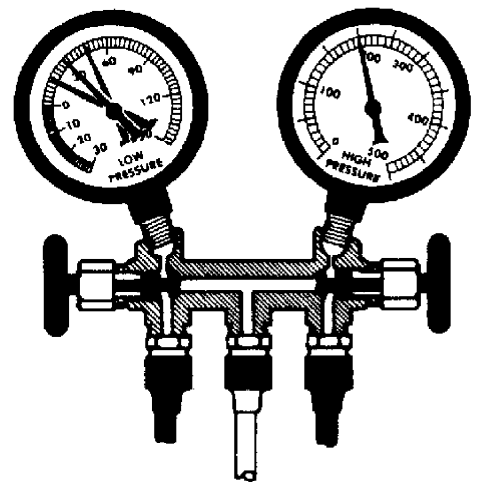


Fig. 7: Misadjusted Thermostatic Switch or Defective Clutch Cycling Switch Gauge Indications  
Courtesy of Ford Motor Co.

Correction With Thermostatic Switch

**NOTE:** If no adjusting screw is provided, the switch is nonadjustable and must be replaced.

- 1) Stop engine and turn air conditioner off.
- 2) Remove components necessary to gain access to thermostatic adjustment screw.
- 3) Make certain that all wiring is positioned so that no short-circuiting can occur. Connect battery cable so that engine can be operated while making switch adjustment.

Adjust thermostatic switch.

#### Correction With Clutch Cycling Switch

NOTE: Switch is non adjustable and is mounted on a Schrader valve fitting. Therefore, no system discharge is required.

- 1) Stop engine and turn air conditioner off.
- 2) Detach electrical connector from pressure sensing switch at accumulator.
- 3) Remove pressure sensing switch, and install a new switch.

### LOW R-12 CHARGE GAUGE READINGS

Low Side Gauge - Low  
High Side Gauge - Low

#### Other Symptoms

Discharge Air - Slightly cool.  
Sight Glass - Some bubbles.

### LOW R-12 CHARGE

#### GAUGE READINGS

Low Side Gauge - Low

High Side Gauge - Low

#### OTHER SYMPTOMS

Discharge Air - Slightly cool.

Sight Glass - Some bubbles.

#### CORRECTION

- 1) Leak test system.
- 2) Discharge refrigerant from system if necessary to replace units or lines.
- 3) Repair leaks.
- 4) Check compressor oil level.  
System may have lost oil due to leakage.
- 5) Evacuate system using vacuum pump.
- 6) Charge system with R-12.
- 7) Operate system and check performance.

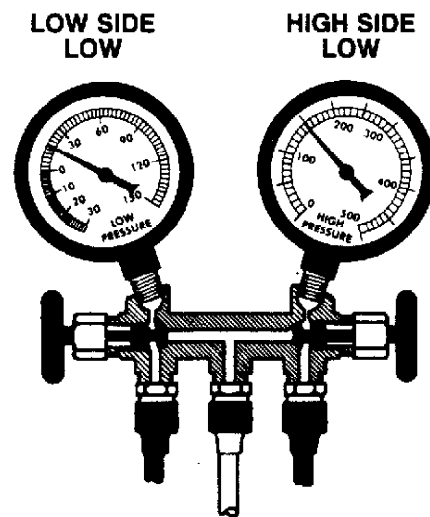


Fig. 8: Low R-12 Charge Pressure Gauge Indications  
Courtesy of Ford Motor Co.

#### Correction

- 1) Leak test system.
- 2) Discharge refrigerant from system if necessary to replace units or lines.
- 3) Repair leaks.
- 4) Check compressor oil level. System may have lost oil due to leakage.
- 5) Evacuate system using vacuum pump.
- 6) Charge system with R-12.
- 7) Operate system and check performance.

### VERY LOW R-12 CHARGE GAUGE READINGS

Low Side Gauge - Low  
High Side Gauge - Low

Other Symptoms

Discharge Air - Warm.  
Sight Glass - Clear or Oil Streaks.  
Compressor - Operation may have stopped if system is equipped with a refrigerant pressure sensing switch.

## VERY LOW R-12 CHARGE

### GAUGE READINGS

Low Side Gauge - Low

High Side Gauge - Low

### OTHER SYMPTOMS

Discharge Air - Warm.

Sight Glass - Clear or Oil Streaks.

Compressor - Operation may have stopped if system is equipped with a refrigerant pressure sensing switch.

### CORRECTION

- 1) If compressor operation is stopped due to a pressure sensing switch, by-pass switch with jumper wire until testing and correction are complete.
- 2) Add a partial refrigerant charge (to at least 50 percent system capacity), then make thorough leak test.
- 3) Discharge refrigerant from system.
- 4) Check compressor oil level.  
System may have lost oil due to leakage.
- 5) Evacuate system using vacuum pump.
- 6) Charge system with R-12.
- 7) Operate system and check performance.

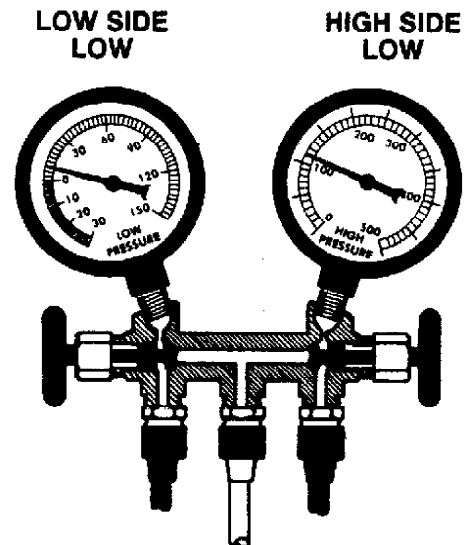


Fig. 9: Very Low R-12 Charge Pressure Gauge Indications  
Courtesy of Ford Motor Co.

### Correction

- 1) If compressor operation is stopped due to a pressure sensing switch, by-pass switch with jumper wire until testing and correction are complete.
- 2) Add a partial refrigerant charge (to at least 50 percent system capacity), then make thorough leak test.
- 3) Discharge refrigerant from system.
- 4) Check compressor oil level. System may have lost oil due to leakage.
- 5) Evacuate system using vacuum pump.
- 6) Charge system with R-12.
- 7) Operate system and check performance.

## EXPANSION OR "H" VALVE STUCK CLOSED GAUGE READINGS

Low-Side Gauge - Low  
High-Side Gauge - Low

Other Symptoms

Discharge Air - Slightly cool  
Evaporator Inlet Pipe - Sweating or frost build up

#### Testing

1) If evaporator inlet is cool to touch, proceed as follows:

- a. Set air conditioner for maximum cooling, and operate the system.
- b. Spray liquid R-12 on head of valve or capillary tube (if equipped). Note low-side gauge reading. Low-side gauge should drop into a vacuum.
- c. If low-side vacuum reading was obtained, warm expansion valve diaphragm chamber with hand, then repeat test step b.
- d. If expansion valve test indicates valve operation is satisfactory, clean contact surface of evaporator outlet pipe and temperature sensing bulb. Ensure bulb is securely in contact with pipe.
- e. If expansion valve test indicates the valve is defective, discharge the system, replace expansion valve, and proceed with correction procedure.

2) If expansion valve inlet shows sweating or frost proceed as follows:

- a. Discharge system.
- b. Disconnect inlet line at expansion valve. Remove and inspect screen.
- c. Clean and replace screen, and reconnect inlet line.
- d. Proceed with correction procedure.

## GAUGE READINGS

Low Side Gauge – Low

High Side Gauge – Low

## OTHER SYMPTOMS

Discharge Air – Slightly cool

Evaporator Inlet Pipe – Sweating or frost build up

## TESTING

- 1) If evaporator inlet is cool to touch, proceed as follows:
  - a. Set air conditioner for maximum cooling and operate the system.
  - b. Spray liquid R-12 on head of valve or capillary tube (if equipped). Note low side gauge reading. Low side gauge should drop into a vacuum.
  - c. If low side vacuum reading was obtained, warm expansion valve diaphragm chamber with hand, then repeat test step b.
  - d. If expansion valve test indicates valve operation is satisfactory, clean contact surface of evaporator outlet pipe and temperature sensing bulb. Make sure bulb is securely in contact with pipe.
  - e. If expansion valve test indicates the valve is defective, discharge the system, replace expansion valve, and proceed with correction procedure.
- 2) If expansion valve inlet shows sweating or frost proceed as follows:
  - a. Discharge system.
  - b. Disconnect inlet line at expansion valve. Remove and inspect screen.
  - c. Clean and replace screen and reconnect inlet line.
  - d. Proceed with correction procedure.

## CORRECTION

- 1) Evacuate system using vacuum pump.
- 2) Charge system with R-12.
- 3) Operate system and check performance.

104008

Fig. 10: Expansion or "H" Valve Stuck Closed  
Courtesy of Ford Motor Co.

### Correction

- 1) Evacuate system using vacuum pump.
- 2) Charge system with R-12.
- 3) Operate system and check performance.

## ORIFICE TUBE PLUGGED GAUGE READINGS

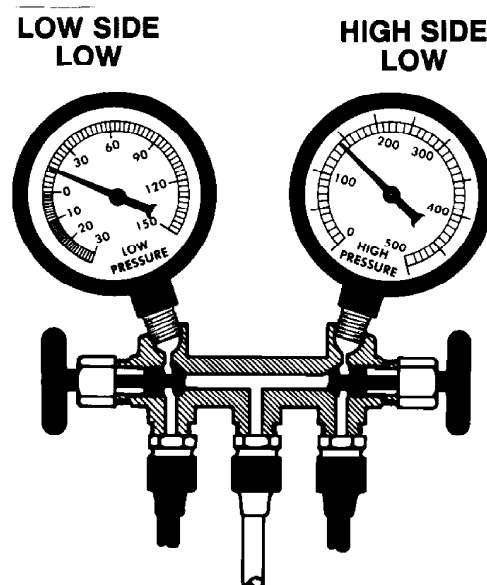
Low Side Gauge – Low

High Side Gauge – Low

### Other Symptoms

Discharge Air – Slightly cool.

Evaporator Inlet Pipe – Sweating or frost build up just ahead of orifice tube.



## Testing

If evaporator inlet pipe after orifice tube and accumulator surface are warm, orifice tube is plugged.

## ORIFICE TUBE PLUGGED

### GAUGE READINGS

**Low Side Gauge** - Low

**High Side Gauge** - Low

### OTHER SYMPTOMS

**Discharge Air** - Slightly cool

**Evaporator Inlet Pipe** - Sweating or frost build up just ahead of orifice tube.

### TESTING

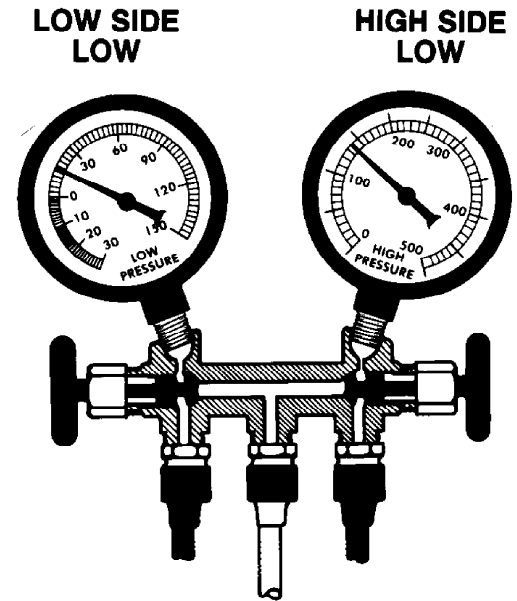
If evaporator inlet pipe after orifice tube and accumulator surface are warm, orifice tube is plugged.

### CORRECTION

- 1) Evacuate system using vacuum pump.
- 2) Replace orifice tube.
- 3) Charge system with R-12.
- 4) Operate system and check performance.

104009

Fig. 11: Orifice Tube Plugged Pressure Gauge Indications  
Courtesy of Ford Motor Co.



### Correction

- 1) Evacuate system using vacuum pump.
- 2) Replace orifice tube.
- 3) Charge system with R-12.
- 4) Operate system and check performance.

## EXPANSION OR "H" VALVE STUCK OPEN GAUGE READINGS

**Low Side Gauge** - High

**High Side Gauge** - High

### Other Symptoms

**Discharge Air** - Warm

**Evaporator** - Sweating or frost.

### Testing

Check for expansion valve stuck open, or incorrect mounting of temperature sensing bulb as follows:

- a. Set air conditioner for maximum cooling and operate system several minutes.
- b. Spray liquid R-12 on head of valve or capillary bulb, and note low side gauge reading. It should drop into a vacuum (if not, a stuck open valve or incorrect bulb mounting is



- indicated). This test may not be possible on applications where sensing bulb is not accessible.
- c. If low side vacuum reading is obtained, warm expansion valve diaphragm chamber with hand, then repeat test.

## EXPANSION OR "H" VALVE STUCK OPEN

### GAUGE READINGS

**Low Side Gauge** - High

**High Side Gauge** - High

### OTHER SYMPTOMS

**Discharge Air** - Warm

**Evaporator** - Sweating or frost.

### TESTING

Check for expansion valve stuck open, or incorrect mounting of temperature sensing bulb as follows:

- a. Set air conditioner for maximum cooling and operate system several minutes.
- b. Spray liquid R-12 on head of valve or capillary bulb, and note low side gauge reading. It should drop into a vacuum (if not, a stuck open valve or incorrect bulb mounting is indicated). This test may not be possible on applications where sensing bulb is not accessible.
- c. If low side vacuum reading is obtained, warm expansion valve diaphragm chamber with hand, then repeat test.

### CORRECTION

- 1) If expansion valve test indicates valve operation is satisfactory, proceed as follows:
  - a. Clean contact surface of evaporator outlet pipe and temperature sensing bulb, then clamp bulb securely in contact with pipe and recover with proper insulation tape.
  - b. Operate system and check performance.

- 2) If expansion valve test indicates valve is defective, proceed as follows:
  - a. Discharge system.
  - b. Replace expansion valve, making sure all contacts are clean and secure.
  - c. Evacuate system using vacuum pump, then charge system with R-12.
  - d. Operate system and check performance.

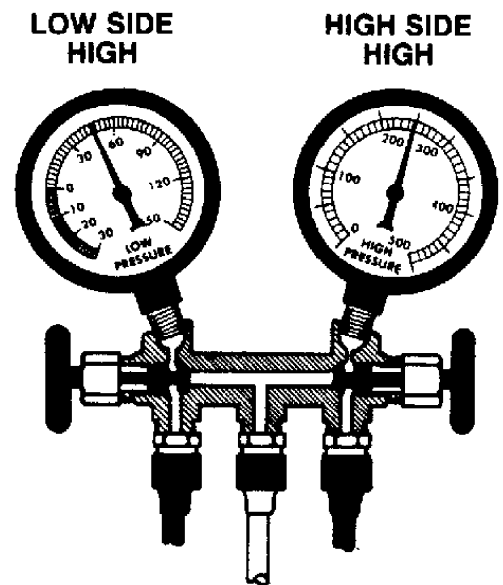


Fig. 12: Expansion or "H" Valve Stuck Open Pressure Gauge Indications  
Courtesy of Ford Motor Co.

### Correction

- 1) If expansion valve test indicates valve operation is satisfactory, proceed as follows:
  - a. Clean contact surface of evaporator outlet pipe and temperature sensing bulb, then clamp bulb securely in contact with pipe and recover with proper insulation tape.
  - b. Operate system and check performance.
- 2) If expansion valve test indicates valve is defective, proceed as follows:
  - a. Discharge system.
  - b. Replace expansion valve, making sure all contacts are clean and secure.
  - c. Evacuate system using vacuum pump, then charge system with R-12.

- d. Operate system and check performance.

## COMPRESSOR MALFUNCTION GAUGE READINGS

Low Side Gauge - High  
High Side Gauge - Low

Other Symptoms

Compressor - Noisy.

### GAUGE READINGS

Low Side Gauge - High

High Side Gauge - Low

### OTHER SYMPTOMS

Compressor - Noisy.

### CORRECTION

- 1) Isolate compressor (if equipped with stem-type service valves) or discharge entire system.
- 2) Remove compressor cylinder head and inspect compressor.
  - a. Replace reed valve plate assembly if necessary.
  - b. Install cylinder head using NEW gasket.
- 3) Check compressor oil level.
- 4) Replace receiver-drier, desiccant or accumulator if:
  - a. System previously opened.
  - b. System operated two or more seasons with present unit.
  - c. Compressor inspection revealed desiccant particles (very fine golden or brown particles).
- 5) Using vacuum pump, evacuate compressor or entire system (depending on procedure used in step 1).
- 6) Charge system with R-12.
- 7) Operate system and check performance.

## COMPRESSOR MALFUNCTION

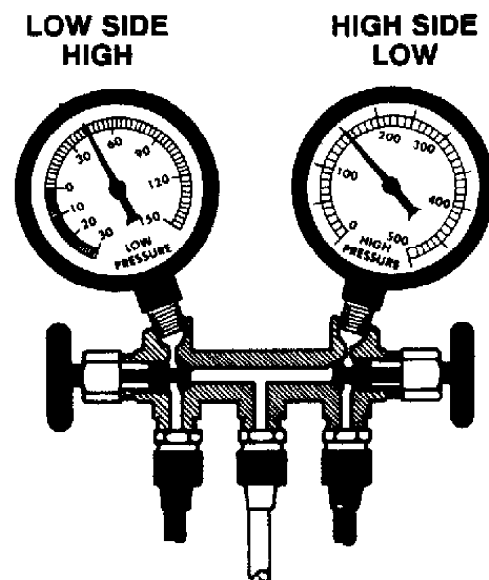


Fig. 13: Compressor Malfunction Pressure Gauge Indications  
Courtesy of Ford Motor Co.

### Correction

- 1) Isolate compressor (if equipped with stem-type service valves) or discharge entire system.
- 2) Remove compressor cylinder head and inspect compressor.
  - a. Replace reed valve plate assembly if necessary.
  - b. Install cylinder head using NEW gasket.
- 3) Check compressor oil level.
- 4) Replace receiver-drier, desiccant or accumulator if:
  - a. System previously opened.
  - b. System operated two or more seasons with present unit.
  - c. Compressor inspection revealed desiccant particles (very fine golden or brown particles).
- 5) Using vacuum pump, evacuate compressor or entire system (depending on procedure used in step 1).
- 6) Charge system with R-12.
- 7) Operate system and check performance.

## CONDENSER MALFUNCTION OR R-12 OVERCHARGE GAUGE READINGS

Low Side Gauge - High  
High Side Gauge - High

### Other Symptoms

Discharge Air - Warm.  
High Side Lines - Very Hot.  
Sight Glass - Bubbles.

## CONDENSER MALFUNCTION OR R-12 OVERCHARGE

### GUAGE READINGS

Low Side Gauge - High

High Side Gauge - High

### OTHER SYMPTOMS

Discharge Air - Warm.

High Side Lines - Very Hot.

Sight Glass - Bubbles.

### CORRECTION

- 1) Check electric cooling fan operation.
- 2) Inspect condenser for clogged air passages, bug screen, or other obstructions preventing airflow through condenser.
- 3) Inspect condenser mounting for proper radiator clearance. Inspect clutch type fan for proper operation. Inspect radiator pressure cap for correct type and proper operation.

#### After Making Above Corrections

Operate system and check performance.

#### If Condition is Not Corrected

- 1) Inspect system for overcharge of refrigerant and correct as follows:
  - a. Discharge refrigerant until stream of bubbles appears in sight glass and both high and low gauge readings drop below normal.
  - b. Add R-12 until bubbles disappear and pressures are normal, then add an additional 1/4-1/2 lb. of refrigerant.
- 2) Operate system and check performance.

#### If Gauge Readings Still Too High

- 1) Discharge system, and remove and inspect condenser to ensure free passage of refrigerant or replace condenser.
- 2) Replace receiver-drier, desiccant bag or accumulator.
- 3) Evacuate system using vacuum pump.
- 4) Charge system with R-12.
- 5) Operate system and check performance.

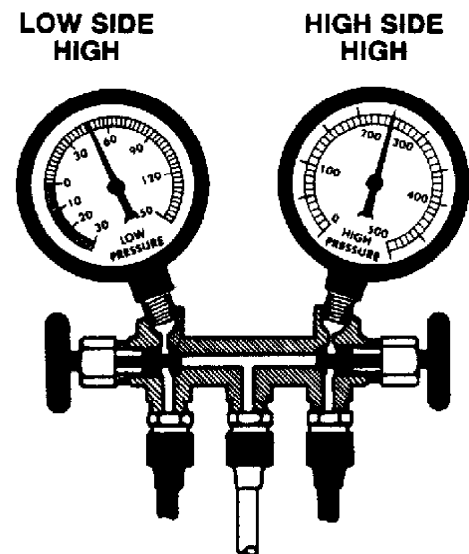


Fig. 14: Condenser Malfunction or R-12 Overcharge Pressure Gauge Indications  
Courtesy of Ford Motor Co.

### Correction

- 1) Check electric cooling fan operation.
- 2) Inspect condenser for clogged air passages, bug screen, or other obstructions preventing airflow through condenser.
- 3) Inspect condenser mounting for proper radiator clearance. Inspect clutch type fan for proper operation. Inspect radiator pressure cap for correct type and proper operation.

After Making Above Corrections. Operate system and check performance. If Condition is Not Corrected.

- 1) Inspect system for overcharge of refrigerant and correct as follows:
  - a. Discharge refrigerant until stream of bubbles appears in sight glass and both high and low gauge readings drop below normal.
  - b. Add R-12 until bubbles disappear and pressures are normal, then add an additional 1/4-1/2 lb. of refrigerant.
- 2) Operate system and check performance. If Gauge Readings Still Too High
  - a. Discharge system, and remove and inspect condenser to ensure free passage of refrigerant or replace condenser.
  - b. Replace receiver-drier, desiccant bag or accumulator.
  - c. Evacuate system using vacuum pump.
  - d. Charge system with R-12.
  - e. Operate system and check performance.

## JEEP

The orifice tube is located in the liquid refrigerant line near the condenser. Orifice tube cannot be replaced as a separate component. If orifice tube is faulty or if compressor is replaced, liquid line must be replaced.

## REFRIGERANT RECOVERY/RECYCLING

NOTE: The use of recovery/recycling equipment is required by law.

Refrigerant recovery/recycling equipment is used to remove refrigerant from vehicle's A/C system without polluting atmosphere. To remove and recycle refrigerant, ALWAYS follow instructions provided with the refrigerant/recovery equipment being used.

The removed refrigerant is filtered, dried and stored in a tank within the recovery/recycling equipment until it is ready to be pumped back into the vehicle's A/C system.

NOTE: Separate sets of hoses, gauges and refrigerant recovery/recycling equipment MUST be used for R-12 and R-134a based systems. DO NOT mix R-12 and R-134a refrigerants, as their refrigerant oils and desiccants are NOT compatible.

Manufacturer recommends using refrigerant recovery/recycling equipment which meets SAE standard J1991. Always use instructions provided with the recovery/recycling equipment being used.

## DISCHARGING A/C SYSTEM

NOTE: When discharging refrigerant from A/C system, use refrigerant recovery/recycling equipment to prevent refrigerant from entering the atmosphere. The use of recovery/recycling equipment is required by law.

Manufacturer does not provide procedures for discharging A/C system. Discharge A/C system using approved refrigerant recovery/recycling equipment. Follow instructions provided with

recovery/recycling equipment for recovery and recycling of refrigerant.

## **FLUSHING A/C SYSTEM**

Information is not available from manufacturer.

## **EVACUATING A/C SYSTEM**

### **CHRYSLER CORP.**

1) Close both valves on manifold gauge set. Connect manifold gauge set to high-side and low-side service valves. See SERVICE VALVE LOCATIONS under SYSTEM SERVICE VALVES. Connect a hose to center connector on manifold gauge set and evacuation pump.

2) Fully open both valves on manifold gauge set. Start evacuation pump, and operate it until a vacuum reading of 26 in. Hg is obtained on low-side gauge. If vacuum reading of 26 in. Hg cannot be reached, either A/C system or gauge set leaks, or evacuation pump is defective. Repair or replace as necessary.

3) When specified vacuum reading has been reached, close both valves on manifold gauge set. Turn off evacuation pump. Observe low-side gauge. If vacuum drops within 30 minutes, system has a leak and must be repaired.

4) If vacuum remains steady, reopen valves, and continue operating evacuation pump for an additional 10 minutes. Close both valves, and stop evacuation pump.

## **CHARGING A/C SYSTEM**

**NOTE:** Manufacturer does not recommend using one-pound cans. Using a charging station will allow precise measurement of refrigerant charge. See REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS at the end of this article for system capacities.

1) System must be evacuated before charging. With manifold gauge set attached from evacuation procedures, attach refrigerant container(s) to hose on center connector of manifold gauge set. Fully open refrigerant container valve(s), purge air from center hose, and close valves.

2) Adjust service valves on the compressor to the mid-position (if equipped). Slowly open low-side valve, and allow refrigerant to enter the system. Start and operate engine. Place A/C-heater controls to maximum cold position.

3) When proper amount of refrigerant has been added, close low-side valve on manifold gauge set. Stop engine, close service valves on compressor, and disconnect manifold gauge set. Start engine, and operate A/C system for 10 minutes to stabilize the system.

## **LEAK TESTING**

Operate system to stabilize high-side and low-side pressures. Turn engine off. Using a refrigerant leak detector, check all refrigerant line connections for leaks. Check compressor seal area and condenser.

Refrigerants are heavier than air. Always check for leaks at bottom of refrigerant lines and components. Refrigerant oil will leak with refrigerant. Visually check all connections and compressor clutch area for oil stains. If compressor shaft seal is leaking, a fresh oil

streak will normally be seen on underside of hood, above compressor clutch.

Always perform leak testing after A/C service. Move refrigerant leak detector slowly to check for leaks, as leaks will not be detected if leak testing is performed too quickly.

## REFRIGERANT OIL & REFRIGERANT SPECIFICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications in table differ, use label specifications.

REFRIGERANT OIL & REFRIGERANT CAPACITY TABLE (LIGHT TRUCKS & VANS)

Application	(1) Oil Ounces	Refrigerant Ounces
Jeep		
Cherokee .....	4.6 .....	38
Grand Cherokee (2) .....	8.0 .....	28
Wrangler .....	4.6 .....	32

(1) - Total system capacity, unless otherwise noted.

(2) - Models use R-134a refrigerant and PAG (ND8) Refrigerant Oil (Part No. 82300102).

## COMPRESSOR APPLICATIONS

NOTE: Due to late changes, always refer to underhood A/C Specification Label in engine compartment or A/C compressor label while servicing A/C system. If A/C Specification Label and specifications differ, use label specifications.

COMPRESSOR APPLICATIONS TABLE (LIGHT TRUCKS & VANS)

Application	Compressor
Jeep	
Cherokee & Wrangler .....	Sanden SD-709 7-Cyl.
Grand Cherokee .....	Nippondenso 10PA17 10-Cyl.

(1) - Series codes are determined by fifth character of VIN code.

# ALTERNATOR - NIPPONDENSO

1993 Jeep Cherokee

1993 ELECTRICAL  
Chrysler Corp. Alternators - Nippondenso

Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## DESCRIPTION

Charging system consists of a Powertrain Control Module (PCM), alternator, CHECK ENGINE light and battery. Voltage regulation is controlled within the PCM and cannot be serviced.

The PCM monitors charging system input and output to ensure correct operation. The PCM stores any charging system failures in memory and outputs fault code(s) when on-board diagnostics are entered.

The PCM monitors several different engine control system circuits. If a problem is detected within a monitored circuit, a fault code is stored in the PCM memory. The CHECK ENGINE light will illuminate and system may enter limp-in mode. In limp-in mode, engine controller compensates for component or circuit failure by using information from other sources until repairs are made.

NOTE: Fault codes remain in memory for 50 engine starts. Fault is erased from memory if failure does not reoccur.

## ADJUSTMENTS

### BELT TENSION

BELT ADJUSTMENT TABLE (1)

Application	Lbs. (kg)
New Belt .....	180-200 (81.72-90.8)
Used Belt .....	140-160 (63.56-72.64)

(1) - Tension in lbs. (kg) using belt tension gauge.

## TROUBLE SHOOTING

### PRELIMINARY CHECKS

Visually inspect wiring and drive belts. If charging system is not working, ensure drive belts are properly tightened. Ensure 12 volts exist at alternator field terminal with ignition on. Ensure battery cables, alternator ground cables and alternator and terminal block connections are clean and tight. Ensure alternator field circuit is not grounded (overcharging).

### UNSTEADY OR LOW CHARGING

Check for loose alternator belt, defective alternator, loose alternator ground wire or corroded battery terminals.

### OVERCHARGING

Check for grounded alternator field wiring or faulty

alternator.

## TESTING (ON-VEHICLE)

### ALTERNATOR OUTPUT

#### Output Wire Resistance (Voltage Drop) Test

1) Ensure battery is charged. Turn ignition off. Disconnect negative battery cable. Connect a 0-150 DC ammeter and a voltmeter (0-18 volts) to vehicle's charging system. See Fig. 1.

2) Connect a carbon pile rheostat between battery terminals. Ensure carbon pile is in OFF position before connecting leads.

CAUTION: Alternator has 2 field terminals. In step 3), DO NOT connect jumper wire to alternator field terminal Dark Green/Orange wire.

3) Connect one end of jumper wire to ground and other end to alternator field terminal Dark Green wire on rear side of alternator. See Fig. 2. Connect negative battery cable.

4) Start engine. Reduce engine speed to idle. Adjust engine speed and carbon pile to maintain 20-amp current flow. Observe voltmeter reading. Voltage drop should be .5 volt or less.

5) If voltage drop is greater than .5 volt, inspect, clean and tighten all connections between alternator BAT (B+) terminal and positive battery post. If wire resistance (voltage drop) is okay, test is complete. Remove all test equipment.

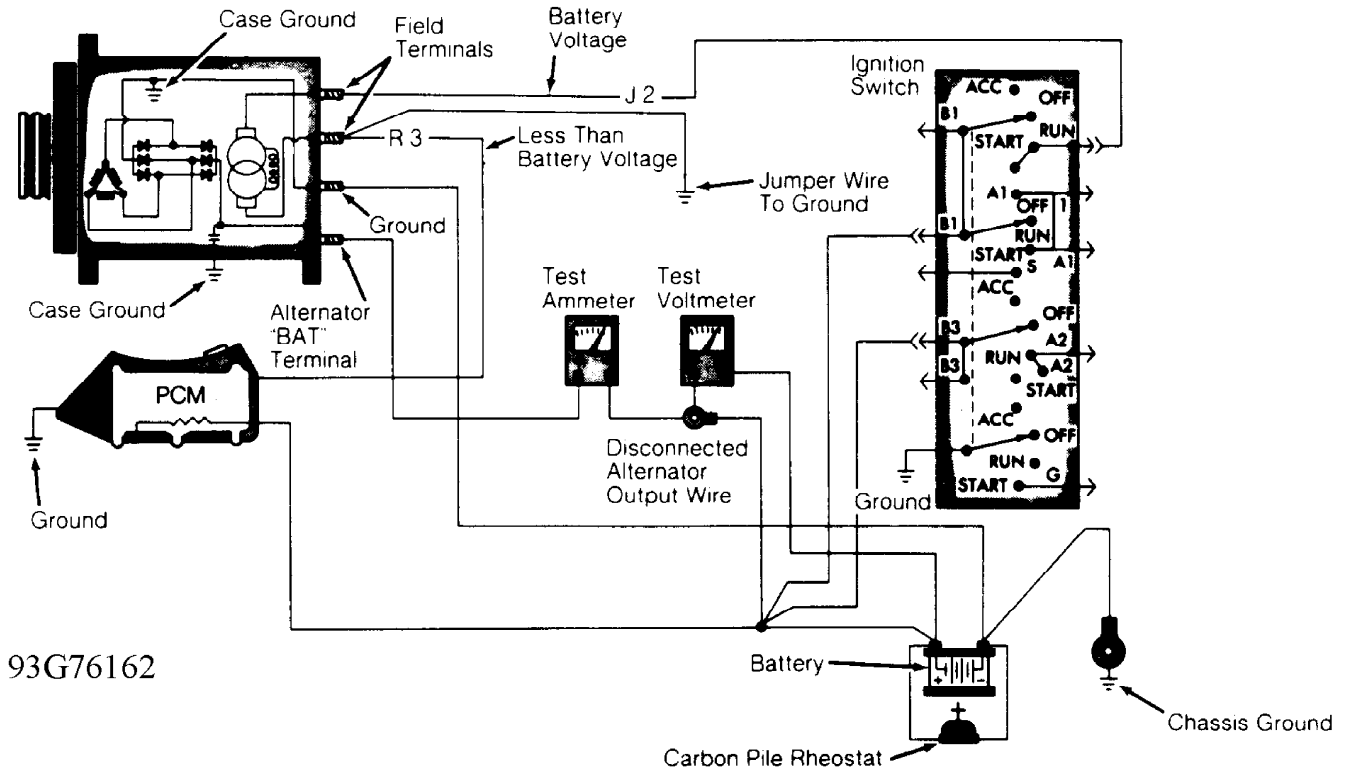


Fig. 1: Testing Alternator Output Wire Resistance (Typical)  
Courtesy of Chrysler Corp.

#### Current Output Test

1) Ensure battery is charged. Turn ignition off. Disconnect



negative battery cable. Connect a 0-150 DC ammeter and a voltmeter (0-18 volts) to vehicle charging system. See Fig. 3.

2) Connect a carbon pile rheostat between battery terminals. Ensure carbon pile is in OFF position before connecting leads.

CAUTION: Alternator has 2 field terminals. In step 3), DO NOT connect jumper wire to alternator field terminal Dark Green/Orange wire.

3) Connect one end of jumper wire to ground and other end to alternator field terminal Dark Green wire on rear side of alternator. See Fig. 2. Connect negative battery cable.

4) Start engine and reduce engine speed to idle. Adjust carbon pile and engine speed until engine speed is 1250 RPM and voltmeter reads 15 volts. DO NOT allow voltage to read greater than 16 volts.

5) Ammeter should read within 10 amps of rating listed on back of alternator. If reading is not as specified, replace alternator. Remove all test equipment.

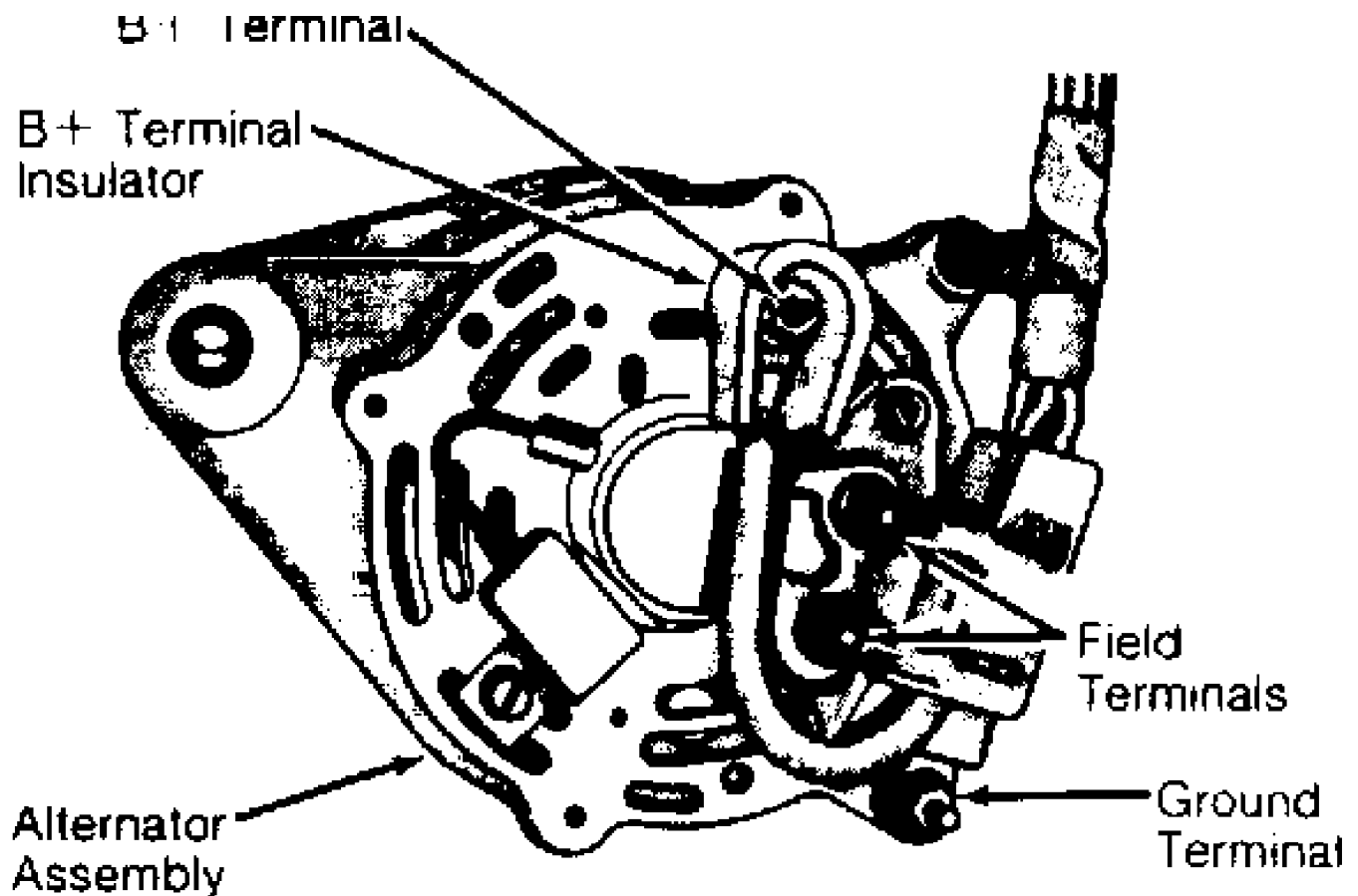
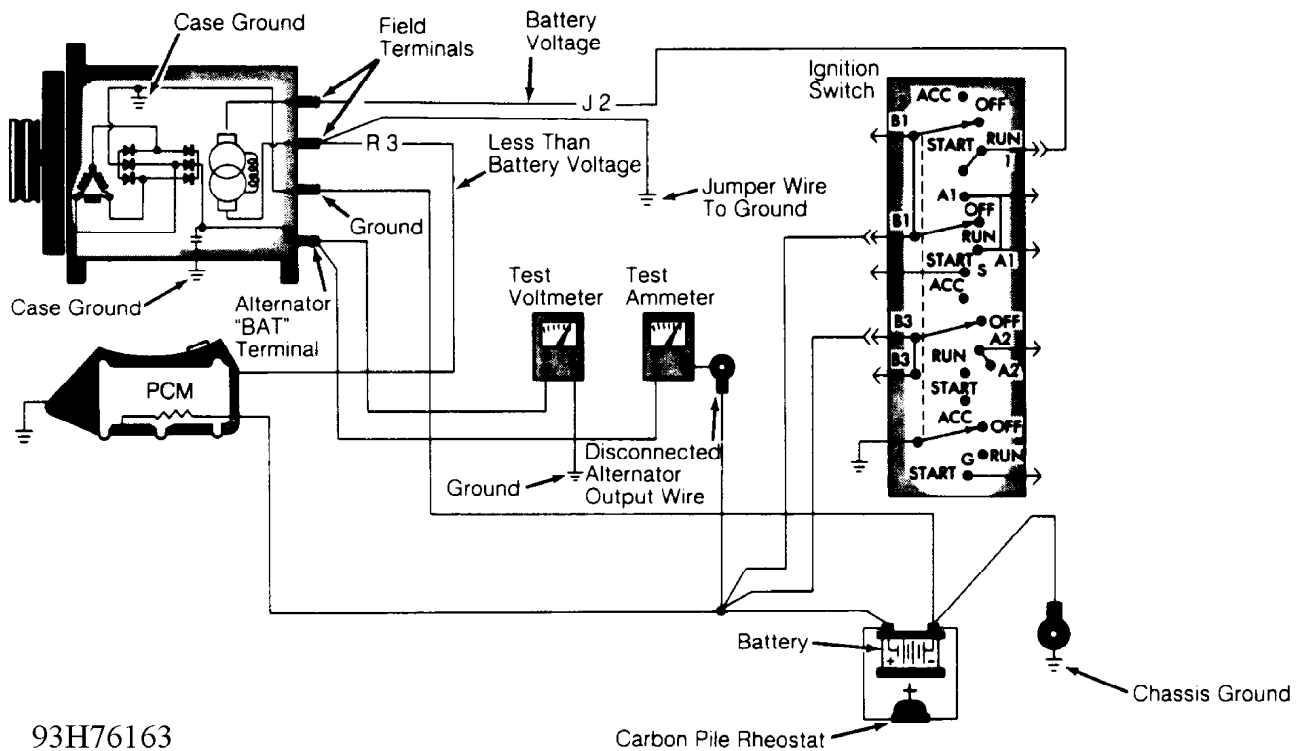


Fig. 2: Identifying Alternator Terminals  
Courtesy of Chrysler Corp.



93H76163  
Fig. 3: Testing Alternator Current Output (Typical)  
Courtesy of Chrysler Corp.

## ENTERING ON-BOARD DIAGNOSTICS

**CAUTION:** Before entering on-board diagnostics, check charging system for other problems. See PRELIMINARY CHECKS under TROUBLE SHOOTING. DO NOT connect DRB-II to vehicle with battery charger connected. Damage to DRB-II may result.

### Reading Trouble Codes

Trouble codes may be read by using the CHECK ENGINE light on instrument panel or using DRB-II. See CHECK ENGINE LIGHT DIAGNOSTIC MODE and DIAGNOSIS USING DRB-II headings below. A more complete diagnosis is possible using DRB-II.

**NOTE:** The PCM CANNOT diagnose every charging system problem. If a fault still exists after performing self-diagnostic procedures, go to TESTING (ON-VEHICLE).

### Trouble Code Explanation

- 1) See the CHARGING SYSTEM FAULT CODES table for charging-related faults.
- 2) Code 41 will set if alternator field control fails to switch properly. PCM monitors this circuit whenever ignition is on.
- 3) If battery temperature sense voltage goes out of range, Code 44 will set in memory. PCM monitors this circuit any time ignition is on.
- 4) If battery voltage is more than one volt above desired control voltage for longer than 20 seconds, Code 46 will be set in memory. PCM monitors this signal whenever engine is running.
- 5) If battery is more than one volt below desired control voltage for more than 20 seconds, Code 47 will be set. Code 47 will also set if no significant change in voltage is detected during alternator test. PCM monitors this signal whenever engine speed is

more than 1500 RPM.

#### CHARGING SYSTEM FAULT CODES TABLE

Code	Circuit	Light Status
41 (1)	..... Alternator Field Control .....	On
44 (1)	..... (2) Battery Temp. Sensor .....	On
46 (1)	..... High Battery Voltage .....	On
47 (1)	..... Low Battery Voltage .....	Off
55	..... End Of Diagnostic Mode .....	Off

- (1) - This code will cause limp-in mode.  
(2) - Sensor inside PCM. If failed, replace PCM.

NOTE: Only charging system-related codes are listed here. For engine-related codes, see appropriate G - TESTS W/CODES article in the ENGINE PERFORMANCE Section.

##### CHECK ENGINE Light Diagnostic Mode

1) Start engine (if possible). On models equipped with automatic transmission, place foot on brake and cycle transmission shift lever through all positions, ending in Park. On all models, turn A/C switch on and then off (if equipped).

2) Turn engine off. Without starting engine, turn ignition on, off, on, off and on. CHECK ENGINE light will come on for 2 seconds as a bulb check, followed by fault codes. Record 2-digit fault codes as displayed by flashing CHECK ENGINE light.

3) Once CHECK ENGINE light begins to flash fault codes, it cannot be stopped. Repeat step 1) to enter diagnostic mode. Code 55 indicates end of fault code display. For more information on vehicle self-diagnostics, see appropriate SELF-DIAGNOSTICS article in the ENGINE PERFORMANCE section.

4) Refer to CHARGING SYSTEM FAULT CODES table to relate trouble code number to a system fault description (DRB-II display). Once trouble area is known, go to appropriate charging system test.

NOTE: CHECK ENGINE light cannot be used to perform actuation test mode, sensor test modes or engine running test. Fault codes can only be erased using DRB-II. Fault codes will be erased from PCM memory after 50 engine starts if fault does not occur again.

##### Diagnosis Using DRB-II

The DRB-II is used as part of the charging system diagnostic procedure. Perform TEST CH-1, BATTERY CONDITION CHECK and also the CHARGING VERIFICATION (CH-VER) test.

##### Erasing Fault Codes

1) To erase faults, press ATM key. At DRB-II display, press "2" (ERASE) key. DRB-II will display ERASE FAULTS ARE YOU SURE? (ENTER TO ERASE). Press ENTER key.

2) When DRB-II is finished erasing fault codes, it will display FAULTS ERASED. This display will remain until ATM key is pressed. After ATM key is pressed, display will return to CHARGING MENU screen.

#### DRB-II TEST FUNCTIONS

NOTE: DO NOT touch DRB-II keypad during DRB-II power-up sequence, or an error message will result.

1) To diagnose system with DRB-II, DRB-II must be in CHARGING MENU. At CHARGING MENU, fault codes and DRB-II test functions can be used.

2) To get to CHARGING MENU, turn ignition off. Attach DRB-II to engine diagnostic connector. Connector is located in engine compartment, near PCM. Turn ignition switch to RUN position.

3) All DRB-II character positions will glow and copyright information will appear on screen for several seconds.

4) After several seconds DRB-II menu will appear. At DRB-II menu, press "4" (SELECT SYSTEM) key. Press ENTER key. At SELECT SYSTEM menu, press "1" (ENGINE) key. Press ENTER key. DRB-II menu will appear, indicating engine year and size, type of transmission and PCM part number.

5) After several seconds AIR COND menu will appear. Press "1" (WITH A/C) or press "2" (WITHOUT A/C). DRB-II display will change to ENGINE SYSTEMS menu. At ENGINE SYSTEMS menu, press "2" (CHARGING) key. Press ENTER key.

6) Display will change to CHARGING MENU. At CHARGING menu of engine diagnostic program, specific test functions programmed into DRB-II can be performed. Following DRB-II modes can be accessed: SYSTEM TEST, READ FAULTS, STATE DISPLAYS, ACTUATOR TEST and ADJUSTMENTS.

#### READ FAULTS Mode

This allows technician to read and erase fault codes. Fault counter will appear along with fault displayed on DRB-II. For example, DRB-II will display 1 OF 2 FAULTS. PCM will store up to 8 fault messages.

Faults are numbered in reverse order of setting. Most recent fault to occur will be number one. Vehicles without A/C will always have A/C CLUTCH RELAY CKT (circuit) stored in memory. This fault will always be number one if vehicle is not equipped with A/C. If no fault messages are stored, DRB-II will display NO FAULTS DETECTED and start counter will show 0 STARTS SINCE ERS.

A start counter will appear below DRB-II fault counter display. Start counter counts the number of times vehicle is started since faults were last set, erased or battery was disconnected. This helps determine if fault is intermittent.

Memory space limits start counter to first 3 faults. Start counter of zero equals a hard fault. Start counter of more than zero indicates an intermittent fault. Start counter will count up to 255 starts. If no fault messages are stored, DRB-II will display NO FAULTS DETECTED and start counter will show 0 STARTS SINCE ERS.

#### STATE DISPLAYS Mode

This allows technician to read status or values of sensors, inputs/outputs and components. PCM can only recognize high and low status on switch circuits. PCM cannot detect the difference between an open or short circuit or a defective switch. If DRB-II displays a change between INPUT HIGH and INPUT LOW, it can be assumed that entire switch circuit to PCM is working.

#### ACTUATOR TEST Mode

This function allows the technician to check operation of output circuits or devices, which PCM cannot detect. DRB-II allows PCM to activate these outputs or devices. so technician can check for proper operation.

Most tests available in this mode provide an audible or visual indication of device operation (click of relay contacts, fuel spray, etc.). With exception of an intermittent condition, if a device functions properly during its test, it, its wiring and its driver circuit are presumably working properly.

#### ADJUSTMENTS Mode

This function allows user to erase fault codes. Function also allows user to reset Emission Maintenance Reminder (EMR) light and mileage.

#### DRB-II Volt/Ohmmeter Mode

To access volt/ohmmeter mode of DRB-II, connect Red volt/ohmmeter test lead to Red port, located on right-top side of DRB-II.

NOTE: Because DRB-II is grounded through engine diagnostic connector, only one volt/ohmmeter test is required when using volt/ohmmeter option.

To access voltmeter, press VOLT/OHM key once. DRB-II is now in voltmeter mode. Touch test probe to connector or wire to be measured. Read voltage on DRB-II display. When voltage testing is complete, press VOLT/OHM key 3 times to exit voltmeter mode.

To access ohmmeter, press VOLT/OHM key t,vice. DRB-II is now in ohmmeter mode. Touch test probe to connector or wire to be measured. Read resistance to circuit ground on DRB-II display. When resistance testing is complete, press VOLT/OHM key twice to exit ohmmeter mode.

#### DRB-II Continuity Meter Mode

Press VOLT/OHM key 3 times. Display will read NO CONTINUITY. Touch test probe to connector or wire to be measured. Read continuity on DRB-II display. When continuity testing is complete, press VOLT/OHM key once to exit continuity meter mode.

#### VEHICLES TESTED Mode

Mode is used to show what vehicles are covered by DRB-II cartridge. To access VEHICLES TESTED mode, turn ignition off. Attach DRB-II to engine diagnostic connector. Connector is located in engine compartment, near PCM.

Turn ignition switch to RUN position. All DRB-II character positions will glow and copyright information will appear on screen for several seconds. After several seconds DRB-II menu will appear.

At DRB-II menu, press VEHICLES TESTED) key. Press ENTER key. DRB-II will display vehicles covered by cartridge. Screen will display for 5 seconds and return to DRB-II menu.

#### HOW TO USE Mode

Enter DRB-II menu display. Refer to VEHICLES TESTED MODE. At DRB-II menu, press 2 (HOW TO USE) key. Press ENTER key. A series of screens will be displayed explaining use of DRB-II keys used to move through engine diagnostic program.

### TEST CH-1, BATTERY CONDITION CHECK

NOTE: Perform PRELIMINARY CHECKS under TROUBLE SHOOTING before proceeding. If battery shows signs of freezing or leakage, battery posts are loose or battery has low electrolyte level, DO NOT test.

1) If battery has a built-in hydrometer, go to step 2). Turn ignition and all accessories off. Ensure battery voltage is 12.0 volts or greater. If voltage is less than 12.0 volts, charge battery and go to step 3).

2) If battery hydrometer is Green, go to step 3). If battery hydrometer is Yellow or a bright color, replace battery and perform CHARGING VERIFICATION (CH-VER) test. If battery hydrometer is dark in color, charge battery and go to next step.

3) Ensure battery cables, terminals and posts are clean and tight. Perform a battery load test by applying a 300-amp load for 15 seconds. Wait 15 seconds to allow battery to stabilize. Apply a load equal to 50 percent of battery cold cranking rating for 15 seconds and record minimum voltage reading.

4) See MINIMUM BATTERY VOLTAGE table. If battery is below volt age, replace battery and perform CHARGING VERIFICATION (CH-VER) test. If voltage reading is okay, go to next step.

MINIMUM BATTERY VOLTAGE TABLE

Battery Temperature	Minimum Volts
70°F (21°C) Or More .....	9.6
60°F (16°C) .....	9.5
50°F (10°C) .....	9.4
40°F (4°C) .....	9.3
30°F (-1°C) .....	9.1
20°F (-7°C) .....	8.9
10°F (-12°C) .....	8.7
0°F (-18°C) .....	8.5

5) Reconnect battery cables. Inspect alternator belt tension and condition. Replace belt as necessary. Start engine. Set engine speed to 2000 RPM for 30 seconds. Turn ignition off. Connect DRB-II. Turn ignition on with engine off. Read faults.

6) If DRB-II displays BATTERY TEMP SENSOR OUT OF LIMIT, replace PCM and perform CHARGING VERIFICATION (CH-VER) test. If DRB-II displays other messages, go to appropriate test. If DRB-II does not display any faults, neither fault messages nor faults are intermittent. Go to TEST CH-5, CHECKING FOR INTERMITTENT PROBLEMS.

## TEST CH-2, ALTERNATOR FIELD NOT SWITCHING PROPERLY (CODE 41 )

NOTE: Perform TEST CH-1, BATTERY CONDITION CHECK before proceeding.

1) Put DRB-II in voltmeter mode. Check voltage of Automatic Shutdown (ASD) circuit by probing Dark Green/Orange wire (Dark Green/Black wire on Grand Cherokee and Grand Wagoneer) at back of alternator. If voltage is less than 10 volts, repair open circuit from ignition switch. If voltage is 10 volts or greater, go to next step.

2) Check voltage of alternator field driver circuit by probing Dark Green wire at back of alternator. If voltage is less than 10 volts, go to next step. If voltage is 10 volts or greater, go to step 6).

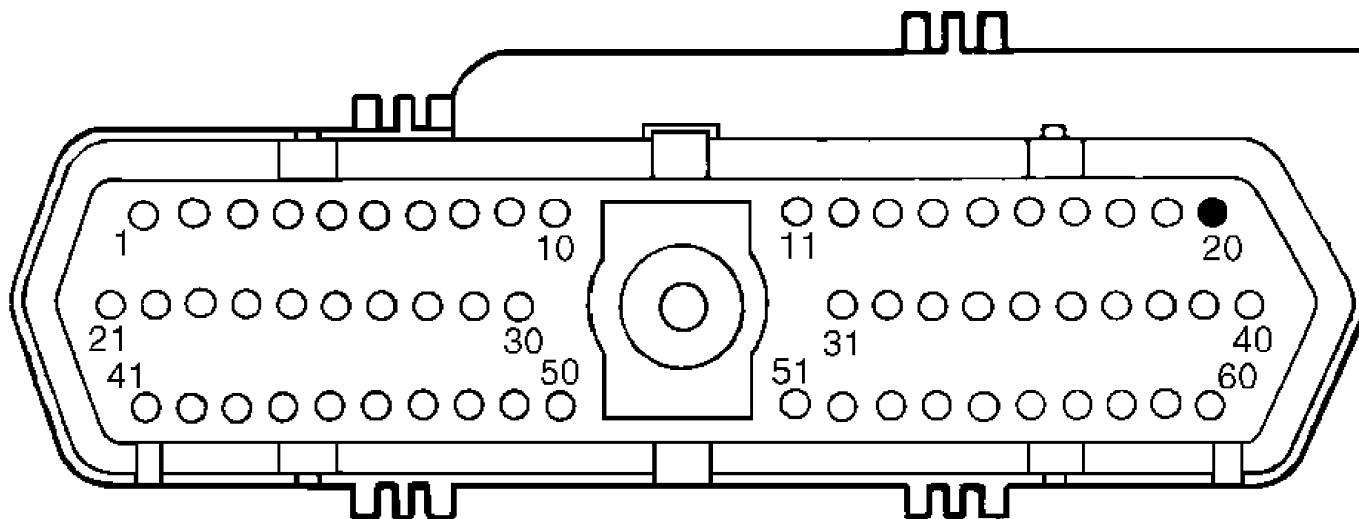
3) Turn ignition off. Disconnect and inspect PCM connector. Repair, if necessary. Disconnect alternator harness from back of alternator. Using an external ohmmeter, check field driver circuit (Dark Green wire) for resistance. If resistance is less than 5.0 ohms, replace PCM. If resistance is 5.0 ohms or greater, repair open in Dark Green wire.

4) Turn ignition off. Disconnect PCM connector. Disconnect alternator harness from back of alternator. Using an external ohmmeter, check for resistance between alternator field terminals. If resistance is 5.0 ohms or greater, replace alternator. If resistance is less than 5.0 ohms, go to next step.

5) With DRB-II in ohmmeter mode, check resistance in field circuit of alternator harness. If resistance is 5.0 ohms or greater, repair short to ground in field driver circuit (Dark Green wire). If resistance is less than 5.0 ohms, replace PCM.

6) Turn ignition off. Disconnect PCM connector. Disconnect alternator harness from back of alternator. Using an external

ohmmeter, check for resistance in field driver circuit alternator harness terminal and cavity No. 20 on PCM connector. See Fig. 4. If resistance is 5.0 ohms or greater, repair short to ground in field driver circuit (Dark Green wire). If resistance is less than 5.0 ohms, replace PCM. Perform CHARGING VERIFICATION (CH-VER) test.



## TERMINAL VIEW OF PCM HARNESS CONNECTOR

93176164

Fig. 4: Identifying PCM Connector Cavities  
Courtesy of Chrysler Corp.

### TEST CH-3, CHARGING SYSTEM VOLTAGE LOW (CODE 47)

NOTE: Perform TEST CH-1, BATTERY CONDITION CHECK before proceeding.

1) If alternator voltage is 15.1 volts or greater, replace PCM. If less than 15.1 volts, ensure no resistance is present between alternator BAT (B+) and battery positive terminal.

CAUTION: Ensure all wires are clear of moving engine parts.

2) Check alternator case for good continuity to ground and negative battery cable. If continuity is good, manually set engine speed to 1600 RPM. Compare voltage on DRB-II and voltage on an external meter. If voltage difference is one volt or greater, replace the alternator. If the difference is less than one volt, proceed to TEST CH-5, CHECKING FOR INTERMITTENT PROBLEMS.

### TEST CH-4, CHARGING SYSTEM VOLTAGE HIGH (CODE 46)

NOTE: Perform TEST CH-1, BATTERY CONDITION CHECK before proceeding.

1) Turn ignition on. Put DRB-II in voltmeter mode. Probe Dark Green wire at back of alternator. If voltage is 10.0 volts or more, go to step 4). If voltage is less than 10.0 volts, turn ignition off. Disconnect PCM connector, inspect and repair if necessary.

2) If connector is okay, turn ignition on. Probe Dark Green wire at back of alternator. If voltage is 10.0 volts or greater, go to step 6). If voltage is less than 10.0 volts, go to next step.

3) Turn ignition off. Disconnect alternator harness from alternator. Put DRB-II in ohmmeter mode. Probe Dark Green wire in

alternator harness. If resistance is less than 10.0 ohms, repair Dark Green wire for short to ground. If resistance is 10.0 ohms or greater, replace alternator. Perform CHARGING VERIFICATION (CH-VER) test.

4) With ignition on and engine off, read voltage. If less than 13.0 volts, replace PCM. Perform CHARGING VERIFICATION (CH-VER) test. If voltage is 13.0 volts or greater, start engine and read voltage. Compare voltage readings before and after engine is running. Watch for a one-volt difference, waiting up to 5 minutes,.

5) If voltage difference is one volt or greater, replace PCM. Perform CHARGING VERIFICATION (CH-VER) test. If difference is less than one volt, go to TEST CH-5, CHECKING FOR INTERMITTENT PROBLEMS.

6) Disconnect negative battery cable. Disconnect PCM connector. Disconnect alternator harness from back of alternator. With DRB-II in ohmmeter mode, check resistance between field driver circuit alternator harness terminal and cavity No. 20 on PCM connector. If resistance is 5.0 ohms or greater, repair short to ground in field driver circuit (Dark Green wire). If resistance is less than 5.0 ohms, go to next step.

7) Probe one of the alternator field terminals. If resistance is 5.0 ohms or greater, replace alternator. If resistance is less than 5.0 ohms, Replace PCM. Perform CHARGING VERIFICATION (CH-VER) test.

## TEST CH-5, CHECKING FOR INTERMITTENT PROBLEMS

NOTE: Perform TEST CH-4, CHARGING SYSTEM VOLTAGE HIGH (CODE 46) before proceeding.

1) Actuate alternator field. Put DRB-II in voltmeter mode. Probe Dark Green wire at back of alternator. Voltage should cycle from zero to battery voltage every 1.4 seconds.

2) While watching DRB-II, wiggle wires between alternator and PCM. If any interruption in the voltage cycle, repair wire at point at which cycle was interrupted. If there is no interruption of voltage cycle, test is complete. Perform CHARGING VERIFICATION (CH-VER) test.

## CHARGING VERIFICATION (CH-VER)

1) Ensure all engine components are connected. If PCM has been changed and if vehicle is equipped with a factory theft alarm system, start vehicle at least 20 times so alarm will activate when desired.

2) Write Emission Maintenance Reminder (EMR) mileage into new PCM. Connect DRB-II to engine diagnostic connector. and erase faults. Recheck system for fault codes.

3) If fault codes reset, charging system still needs repair. Check all pertinent TECHNICAL SERVICE BULLETINS, and return to the TEST CH-1, BATTERY CONDITION CHECK.

## BENCH TESTING

NOTE: Alternators are not serviceable. Replace, if defective.

## OVERHAUL

Overhaul information is not available.

## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

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Application	Ft.	Lbs	(N.m)
Alternator Mounting Bolts .....	28	(38)	
Idler Pulley (Power Steering) .....	20	(27)	

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# ANTI-LOCK BRAKE SYSTEM

## 1993 Jeep Cherokee

1993 BRAKES  
Chrysler Corp. Anti-Lock - Teves

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION

The Teves Mark IV Anti-Lock Brake System (ABS) consists of acceleration switch, Controller Anti-Lock Brake (CAB), ANTI-LOCK warning light, Hydraulic Control Unit (HCU), main relay, master cylinder, pedal travel sensor, pump motor relay, pump motor sensor, vacuum booster, 4 wheel speed sensors and axle shaft tone (pulse) rings.

During ABS operation, front wheels are controlled individually and rear wheels are controlled together. ABS modulates brake fluid pressure during high pedal pressure and high vehicle deceleration to prevent wheel lock-up.

NOTE: For more information on brake system, see BRAKE SYSTEM article in this section.

### OPERATION

The Teves Mark IV Anti-Lock Brake System (ABS) is activated during hard braking to prevent wheel lock-up. Wheel lock-up does not mean wheel has stopped, but wheel is turning slower than vehicle speed. When ignition is on, before vehicle is moved, Controller Anti-Lock Brake (CAB) performs a static system initialization. When vehicle speed reaches approximately 6 MPH, CAB briefly cycles pump to verify operation. Hydraulic Control Unit (HCU) solenoids are checked continuously.

When ABS is activated, vibrations and pulsations may be felt in brake pedal and solenoid valves clicking and pump motor running may be heard. Some wheel slip is required for best braking performance. This wheel slip may be heard as tire chirping. Do not confuse tire chirping with tire skidding. When vehicle is braked heavily, wheels will lock-up below 3 MPH. When braking on rough road surfaces, ABS may activate, detecting wheel lock-up tendencies from wheel hop.

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS article in GENERAL INFORMATION.

### BLEEDING BRAKE SYSTEM

NOTE: Use only DOT 3 brake fluid from a sealed container. DO NOT use DOT 5 silicone brake fluid.

1) Ensure ignition is off. Clean master cylinder reservoir cover and surrounding area. Ensure reservoir is full. Bleeding sequence is master cylinder, Hydraulic Control Unit (HCU) valve body (at fluid lines), right rear wheel, left rear wheel, right front wheel and left front wheel.

2) After bleeding master cylinder, position shop towel below 4 hydraulic control unit brakelines. Using flare wrench, slightly open hydraulic control unit brakeline fittings individually.

3) DO NOT allow brake fluid to contact paint or electrical connectors. Slowly depress brake pedal. Close hydraulic control unit brake pipe fitting and release brake pedal. Repeat process until no

air escapes from brake pipe fitting. Repeat procedure for remaining 3 brakelines.

4) Ensure master cylinder reservoir is full. Raise and support vehicle. Bleed all 4 wheel calipers. Attach a clear hose to right rear caliper bleeder valve and submerge other end of hose in container of brake fluid.

NOTE: DO NOT pump brake pedal while bleeding brakes. Pumping brake pedal compresses air into tiny bubbles throughout system making bleeding more difficult.

5) Open bleeder valve. Slowly depress brake pedal. Close bleeder valve and release brake pedal. Wait 5 seconds. Repeat process until no air bubbles are seen from hose. Tap lightly on cylinder/caliper housing to free trapped air. Close bleeder valve. Repeat process until no air bubbles are seen from hose. Repeat procedure on left rear, right front and left front bleeder valves. Ensure reservoir is full.

6) Using DRB-II, follow prompts and perform BLEED BRAKES procedure. After performing BLEED BRAKES procedure using DRB-II, repeat steps 1)-5). Ensure master cylinder reservoir is full.

## ADJUSTMENTS

### REAR WHEEL SPEED SENSOR

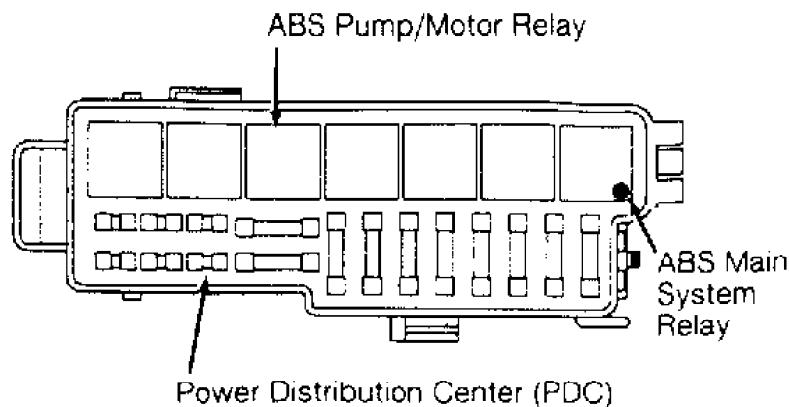
See REAR WHEEL SPEED SENSOR under REMOVAL & INSTALLATION.

## REMOVAL & INSTALLATION

### ABS MAIN SYSTEM RELAY

Removal & Installation

ABS main system relay is located on right side of engine compartment in Power Distribution Center (PDC). Turn ignition off. Remove cover from PDC. Locate and remove ABS main system relay from PDC. See Fig. 1. To install, reverse removal procedure.



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Fig. 1: Locating ABS System Relays  
Courtesy of Chrysler Corp.

### ABS PUMP/MOTOR RELAY

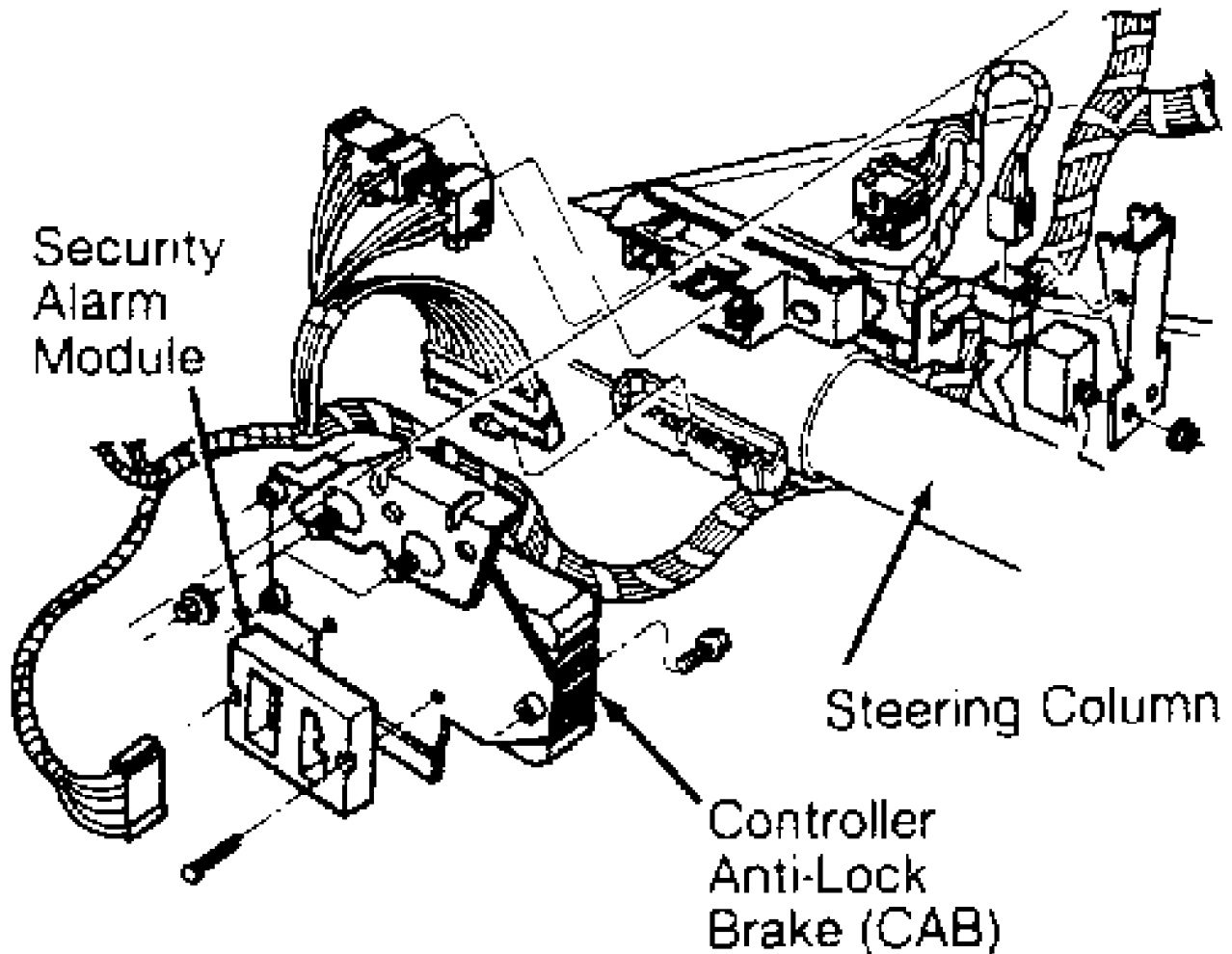
#### Removal & Installation

ABS pump/motor relay is located on right side of engine compartment in Power Distribution Center (PDC). Turn ignition off. Remove cover from PDC. Locate and remove ABS pump/motor relay from PDC. See Fig. 1. To install, reverse removal procedure.

### CONTROLLER ANTI-LOCK BRAKE (CAB)

#### Removal & Installation (Cherokee)

Turn ignition off. CAB is located under instrument panel to right of steering column. Remove screws attaching CAB mounting bracket to vehicle. Disconnect CAB electrical connector. Disconnect security alarm module electrical connector. Security alarm module is mounted on opposite side of mounting bracket. Remove CAB and mounting bracket. See Fig. 2. To install, reverse removal procedure. If installing a new CAB, transfer mounting bracket to new CAB.



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Fig. 2: Locating Controller Anti-Lock Brake (CAB)  
Courtesy of Chrysler Corp.

CAUTION: DO NOT force CAB electrical connector onto CAB. CAB pins are easily damaged.

#### Removal & Installation (Grand Cherokee & Grand Wagoneer)

Turn ignition off. Disconnect negative battery cable. CAB is located on driver-side inner fender panel. Remove screws attaching CAB to fender panel bracket. Remove CAB from bracket for access to CAB electrical connector. Release strap securing harness connector to CAB. Tilt CAB electrical connector upward to disengage. Slide CAB electrical connector from retaining tangs. Remove CAB from vehicle. To install, reverse removal procedure.

#### Removal & Installation (Wrangler)

1) Turn ignition off. Disconnect negative battery cable. CAB is located above heater/air conditioning plenum housing in line with the glove box. Remove bolts and nuts securing CAB to dash panel. Bolts and nuts are accessible from the engine compartment and are located to the right of the battery.

2) On models with air conditioning, remove air conditioning fascia panel and ducts to access CAB harness connector. Release strap securing harness connector to CAB. Tilt CAB electrical connector outward to disengage. Slide CAB electrical connector from retaining tangs. Remove CAB from vehicle. To install, reverse removal procedure.

### FRONT WHEEL SPEED SENSOR

#### Removal & Installation

1) Turn ignition off. Raise and support vehicle. Remove wheel and tire assembly. Clean area surrounding wheel speed sensor prior to removal. Remove bolt attaching wheel speed sensor to steering knuckle.

2) Unseat grommet retaining wheel speed sensor wire in wheel well panel. Disconnect wheel speed sensor electrical connector in engine compartment. Disconnect wheel speed sensor wire harness from clips on body, chassis, and steering knuckle. Remove wheel speed sensor from vehicle.

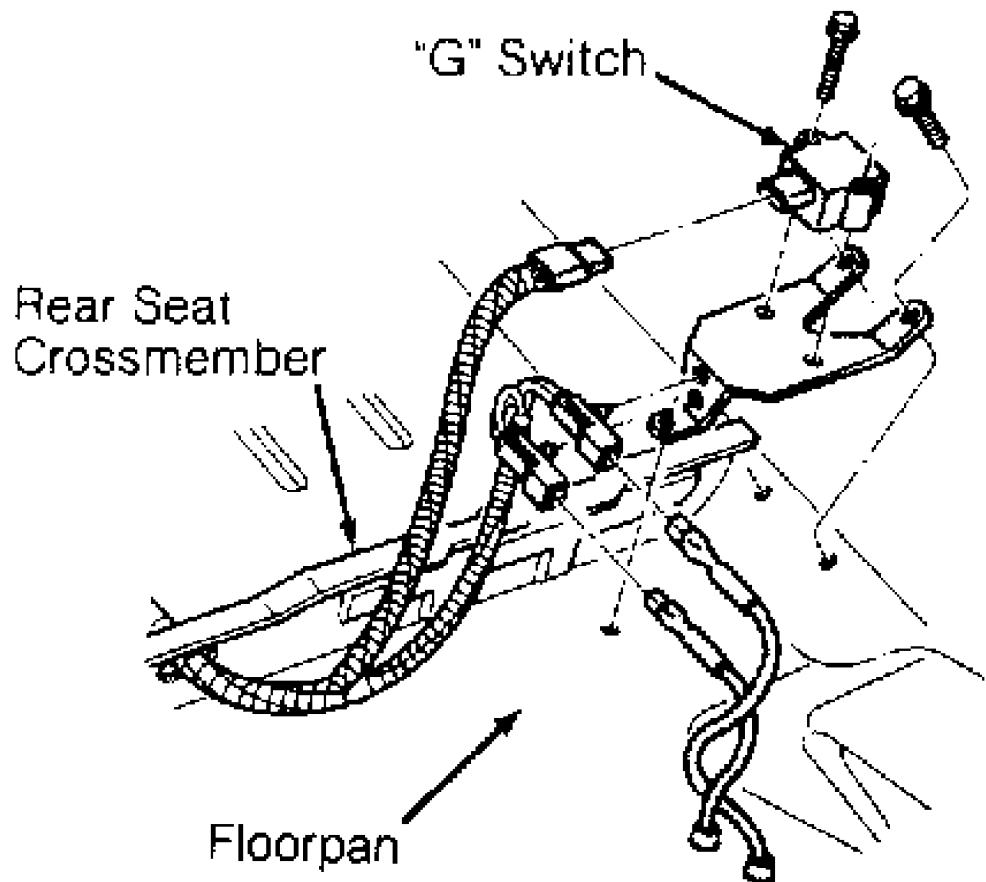
3) To install, reverse removal procedure. Remove all kinks and twists from wheel speed sensor wire harness. Ensure wheel speed sensor wire harness is installed in clips on body, chassis and steering knuckle. Use Loctite on wheel speed sensor mounting bolt.

4) Tighten wheel speed sensor bolt to specification. See TORQUE SPECIFICATIONS table. Air gap is not adjustable. Air gap should be .040" (1.3 mm). If air gap is not to specification, replacement of wheel speed sensor and/or tone wheel may be necessary.

### "G" SWITCH

#### Removal & Installation (Except Wrangler)

Turn ignition off. Disconnect negative battery cable. Tilt rear seat assembly forward to access "G" switch. Disconnect "G" switch electrical connector. Remove "G" switch mounting bolts. Remove "G" switch. See Fig. 3. To install, reverse removal procedure. Ensure arrow on top of "G" switch is facing toward front of vehicle.

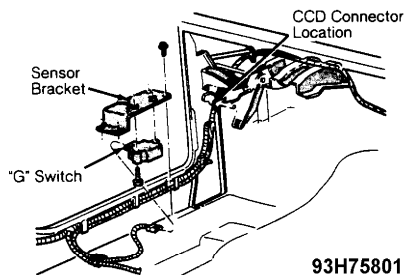


**92G22638**

Fig. 3: Locating "G" Switch (Typical Except Wrangler)  
Courtesy of Chrysler Corp.

#### Removal & Installation (Wrangler)

Turn ignition off. Disconnect negative battery cable. Move driver's seat assembly forward or rearward to access "G" switch. Disconnect "G" switch electrical connector. Remove "G" switch mounting bracket-to-floorpan screws. Remove "G" switch from mounting bracket. See Fig. 4. To install, reverse removal procedure. Ensure arrow on top of "G" switch is facing toward front of vehicle.



**93H75801**

Fig. 4: Locating "G" Switch & CCD Connector (Wrangler)  
Courtesy of Chrysler Corp.

**HYDRAULIC CONTROL UNIT (HCU)**

#### Removal & Installation

1) Turn ignition off. Disconnect negative battery cable. Disconnect pedal travel sensor electrical connector. Remove air cleaner and hoses. On Grand Cherokee and Grand Wagoneer, remove windshield washer reservoir. On all models, position a small drain container under master cylinder reservoir hoses. Disconnect master cylinder reservoir hoses at HCU and drain fluid into container. See Fig. 5. Discard fluid. Disconnect HCU electrical connectors.

2) On Grand Cherokee and Grand Wagoneer, remove combination valve. On all models, identify HCU brakelines for reassembly reference. Disconnect brakelines from HCU. Remove bolt and nuts attaching HCU mounting bracket to inner fender panel. Remove HCU from vehicle. To install, reverse removal procedure. Bleed brake system. See BLEEDING BRAKE SYSTEM.

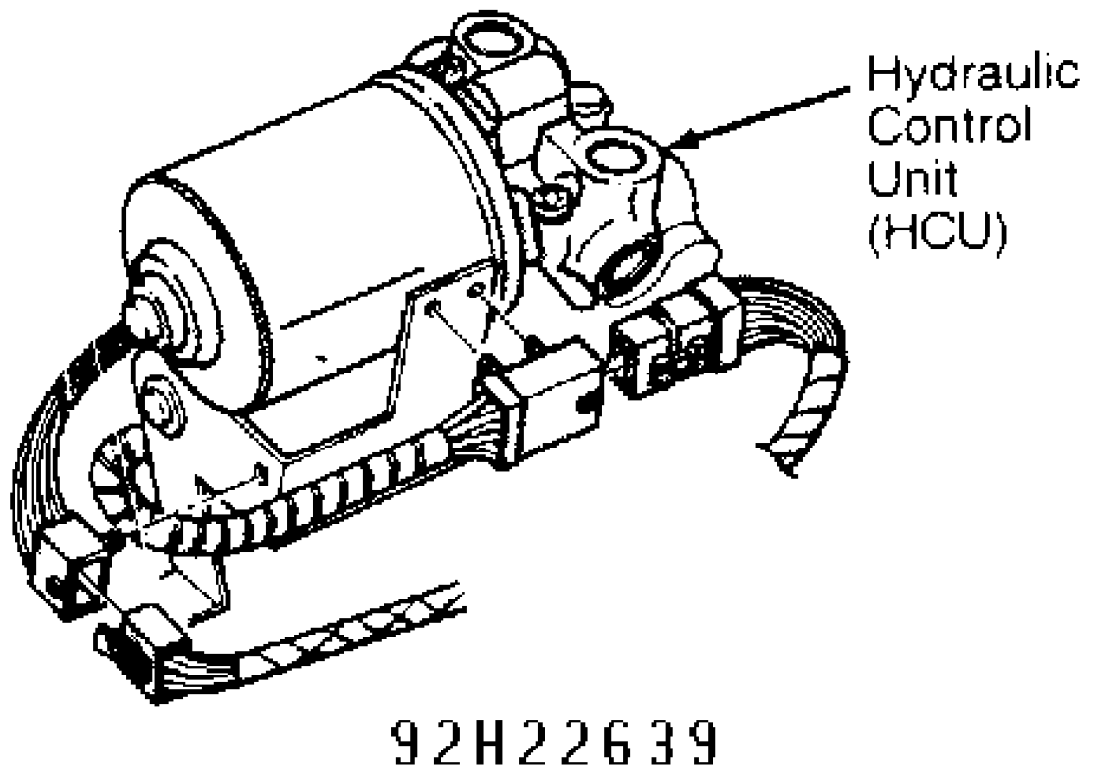
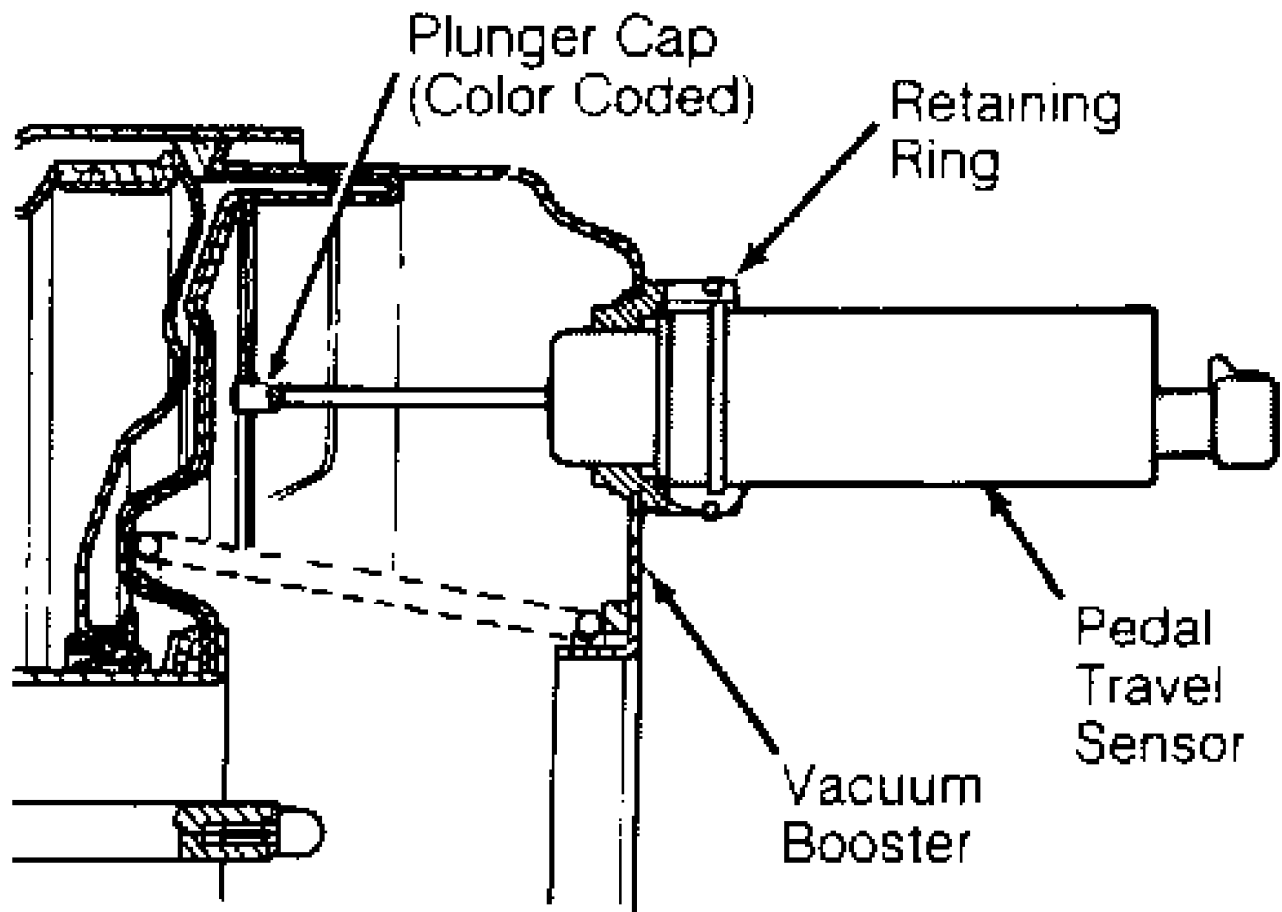


Fig. 5: Locating Hydraulic Control Unit (HCU)  
Courtesy of Chrysler Corp.

#### PEDAL TRAVEL SENSOR

##### Removal & Installation

Turn ignition off. Disconnect pedal travel sensor electrical connector. Pump brake pedal to exhaust all vacuum from vacuum booster. Unseat pedal travel sensor retaining ring. Remove pedal travel sensor from vacuum booster. See Fig. 6. To install, reverse removal procedure. Ensure color dot on face of vacuum booster matches color of plunger tip. If colors are different, replace plunger tip to match color dot on vacuum booster.



92A22640

Fig. 6: Locating Pedal Travel Sensor  
Courtesy of Chrysler Corp.

## REAR WHEEL SPEED SENSOR

### Removal

1) Turn ignition off. Raise and fold rear seat to access rear wheel speed sensor connectors. Disconnect rear wheel speed sensor electrical connector. Push rear wheel speed sensor grommet and wire harness through floorpan on vehicle.

2) Raise and support vehicle. Remove wheel and brake drum. Remove clips attaching rear wheel speed sensor wire harness to brakelines. Unseat rear wheel speed sensor grommet from brake backing plate. Remove rear wheel speed sensor mounting bolt. Push rear wheel speed sensor through grommet opening in backing plate. Remove rear wheel speed sensor from vehicle.

### Installation

1) If original wheel speed sensor is being installed, go to step 3). If a NEW wheel speed sensor is being installed, position wheel speed sensor until cardboard spacer contacts tone wheel.

2) Use Loctite on the wheel speed sensor mounting bolt. Tighten wheel speed sensor mounting bolt to specification. Refer to



TORQUE SPECIFICATIONS. Spin rear axle by hand until cardboard spacer is peeled from sensor face. Air gap adjustment should be correct. Using a brass feeler gauge, check air gap adjustment. Air gap should be .043" (1.1 mm). If air gap is not correct, adjust as necessary. Go to step 4).

3) Remove any remaining pieces of cardboard from sensor face. Install wheel speed sensor. Using a brass feeler gauge, adjust air gap. Air gap should be .043" (1.1 mm). Use Loctite on wheel speed sensor mounting bolt. Tighten wheel speed sensor mounting bolt to specification. See TORQUE SPECIFICATIONS.

4) Remove all kinks and twists from wheel speed sensor wire harness. Ensure wheel speed sensor wire harness is installed in clips on brakelines. To complete installation, reverse removal procedure.

## DIAGNOSIS & TESTING

NOTE: DRB-II and appropriate cartridge are necessary for diagnosing ABS.

## WARNING LIGHTS

### Amber ABS Warning Light

After engine start-up, ABS warning light glows as part of a self-check feature. ABS warning light normally will light for 2-3 seconds and then go out. If ABS warning light remains illuminated after engine start-up, diagnosis will be necessary to determine which component or circuit is malfunctioning.

### Red BRAKE Warning Light

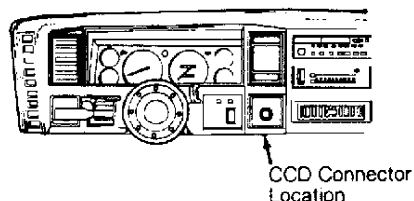
With ignition on, Red BRAKE warning light will glow when low brake fluid level is detected or parking brake switch is closed. BRAKE warning light normally indicates a hydraulic or mechanical failure is present.

## PRE-DIAGNOSTIC INSPECTION

1) Check master cylinder reservoir for correct fluid level. Inspect Hydraulic Control Unit (HCU) for leakage and wiring damage. Check caliper piston for activation and release. Check all brakes to verify no drag exists.

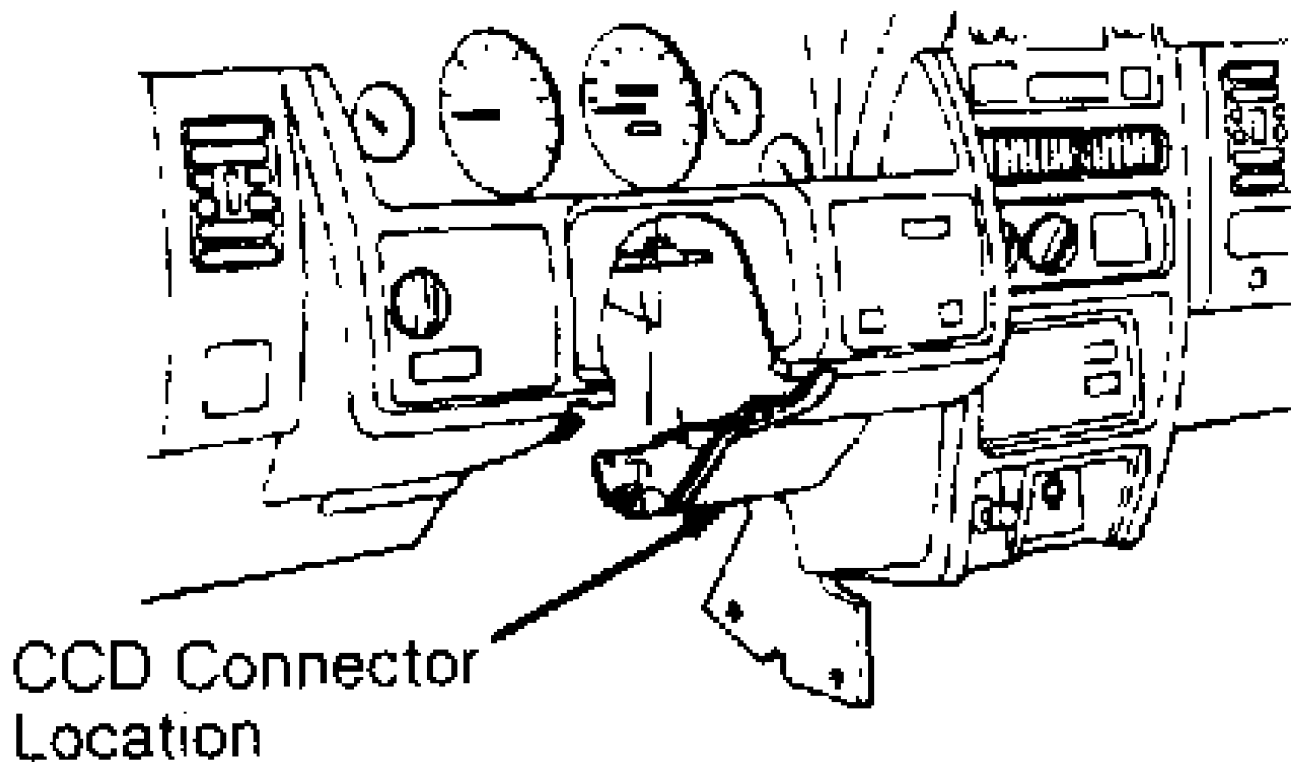
2) Check speed sensors for correct mounting and alignment. Inspect wire harness for correct routing. Ensure connectors are not damaged and have good contact.

3) Verify all wheel bearings are not worn or causing wheel wobble. Ensure all tires are in good condition and properly inflated. After performing pre-diagnostic inspection, perform TEST-1A under SELF-DIAGNOSTIC TESTS using DRB-II. See Figs. 4, 7 and 8.



92B22641

Fig. 7: Locating CCD Connector (Cherokee)  
Courtesy of Chrysler Corp.



92C22642

Fig. 8: Locating CCD Connector (Grand Cherokee & Grand Wagoneer)  
Courtesy of Chrysler Corp.

## INTERMITTENTS

Most intermittent problems are caused by faulty electrical connections or wiring; however, a sticking relay or solenoid can cause a failure.

When intermittent failure is encountered, check for fault messages stored in CAB. If fault messages are found, inspect related components and circuitry for poor connections. If no trouble codes are found, inspect suspect circuits as follows:

- \* Check for poor mating of connector halves, or terminals not fully seated in connector body (backed-out).
- \* Check for improperly formed or damaged terminals. Carefully reform all connector terminals of problem circuit to increase contact tension.
- \* Check for poor terminal-to-wire connection.
- \* Check for hydraulic system leaks.

## CLEARING FAULT MESSAGES

DRB-II

Using DRB-II, select ADJUSTMENTS. Press "1" (ERASE FAULTS key). Press ENTER key. DRB-II will display ERASE FAULTS ARE YOU SURE? (ENTER TO ERASE). Press ENTER key. DRB-II will display ERASE FAULTS TURN KEY OFF. Turn ignition off. Turn ignition on. DRB-II will display

ERASE FAULTS FAULTS ERASED. Faults are now erased.

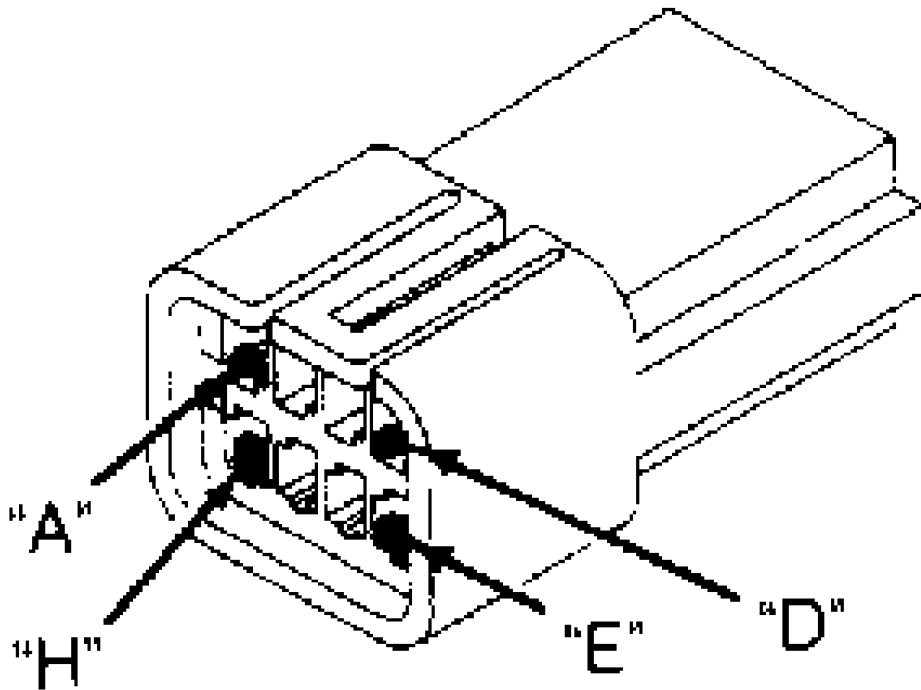
Ignition Cycle Default

If no fault codes occur for 50 driving cycles, any existing fault messages will be cleared from CAB memory. A drive cycle occurs when ignition is turned on and vehicle is driven faster than 10 MPH.

CONNECTOR IDENTIFICATION

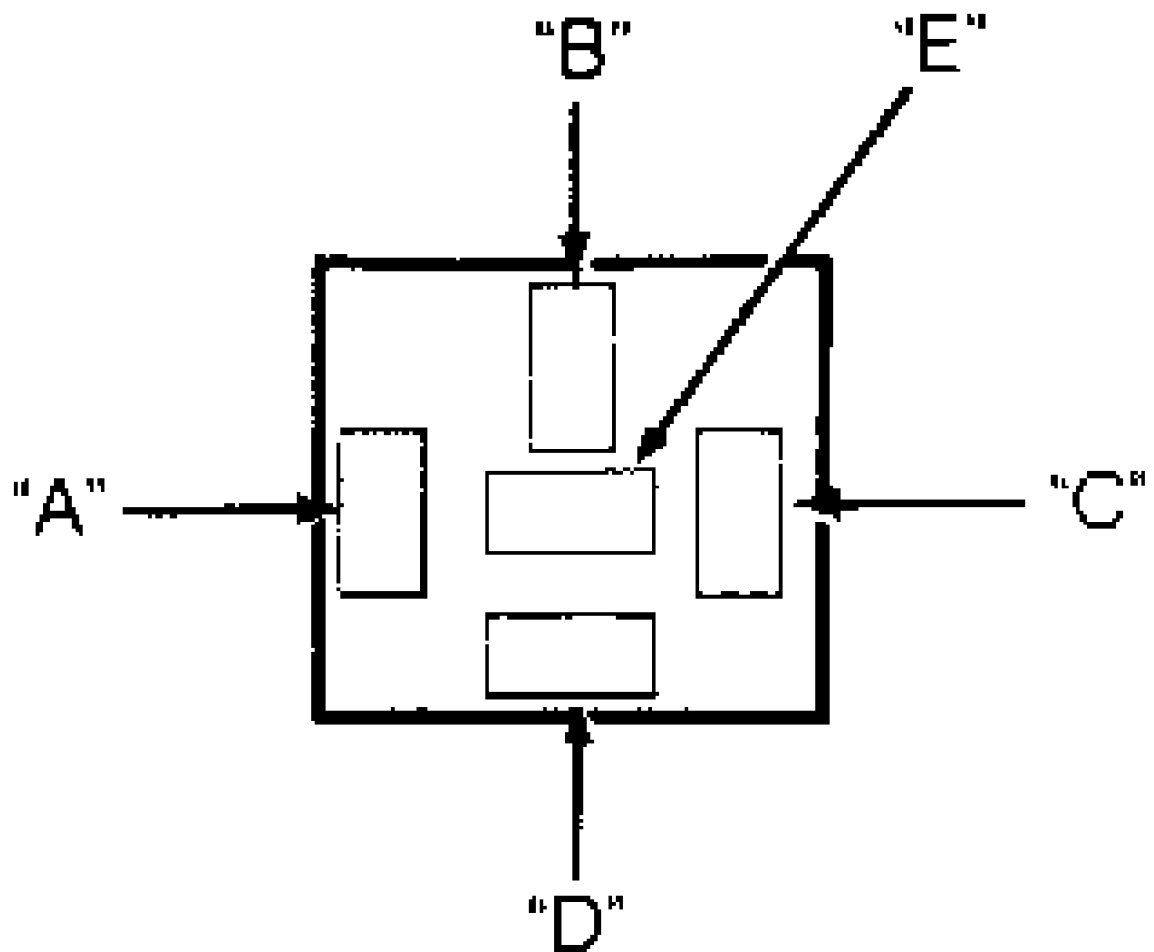
CONNECTOR IDENTIFICATION DIRECTORY TABLE

Connector	Figure
ABS Disconnect Connector .....	9
ABS Main System Relay Socket Connector .....	10
ABS Pump/Motor Relay Socket Connector .....	11
Controller Anti-Lock Brake (CAB) Connector .....	12
"G" Switch Connector .....	13
Hydraulic Control Unit (HCU) Connector .....	14
Pump/Motor Connector .....	15



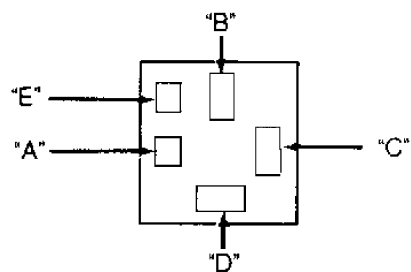
92022643

Fig. 9: Identifying ABS Disconnect Connector Terminals  
Courtesy of Chrysler Corp.



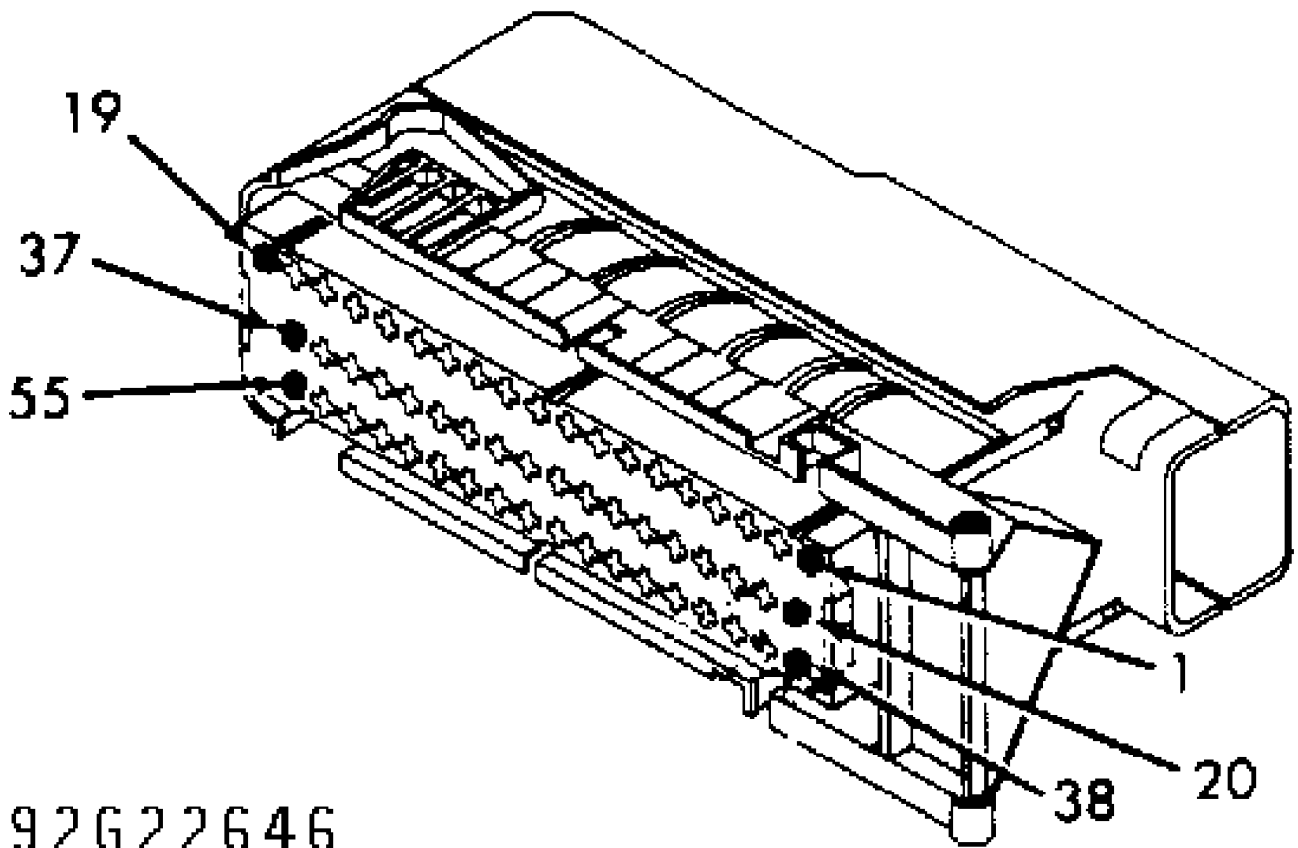
92E22644

Fig. 10: Identifying ABS Main System Relay Connector Terminals  
Courtesy of Chrysler Corp.



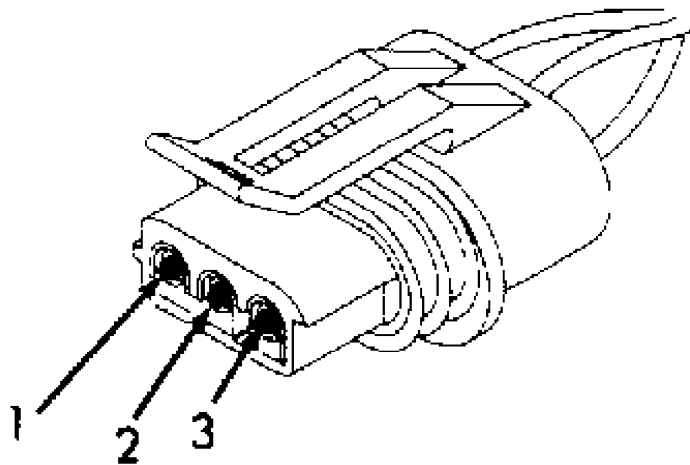
92F22645

Fig. 11: Identifying ABS Pump/Motor Relay Connector Terminals  
Courtesy of Chrysler Corp.



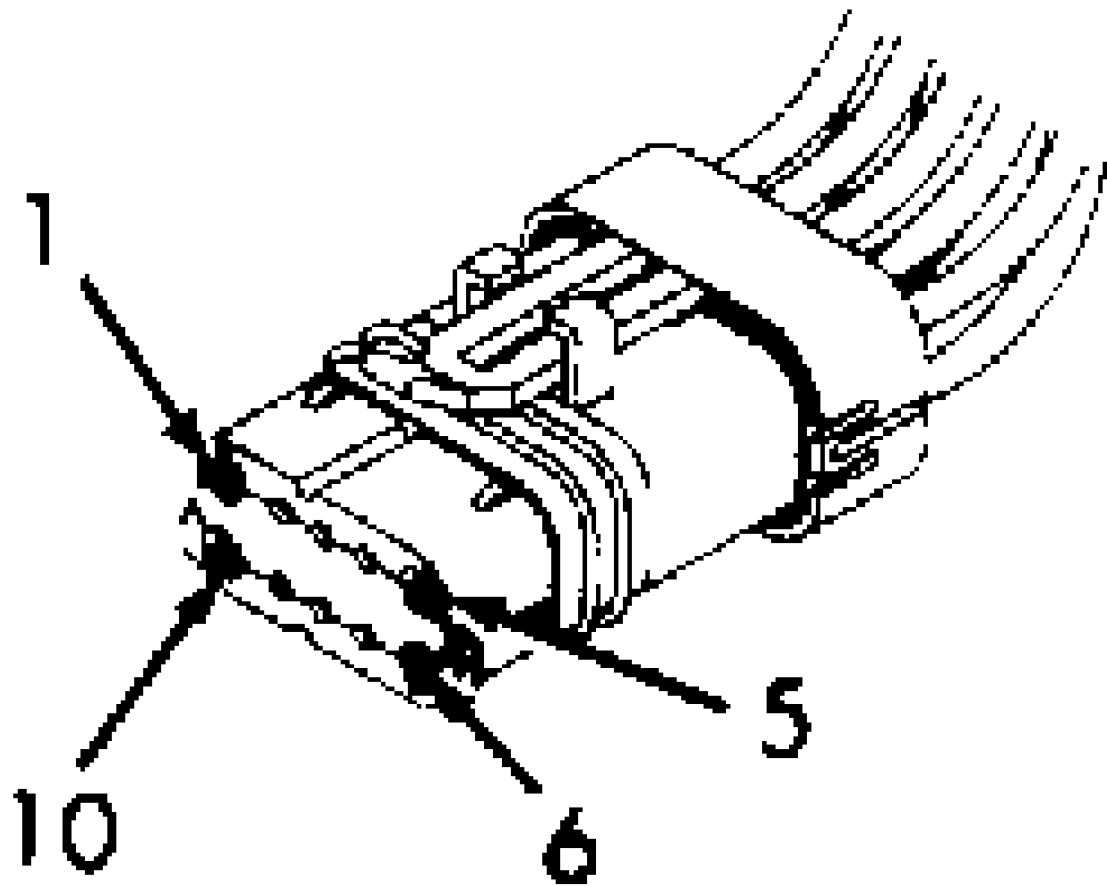
92G22646

Fig. 12: Controller Anti-Lock Brake (CAB) Connector Terminal ID  
Courtesy of Chrysler Corp.



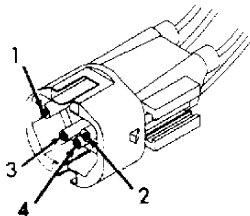
92H22647

Fig. 13: Identifying "G" Switch Connector Terminals  
Courtesy of Chrysler Corp.



92J22648

Fig. 14: Hydraulic Control Unit (HCU) Connector Terminal ID  
 Courtesy of Chrysler Corp.



92J22649

Fig. 15: Identifying Pump/Motor Connector Terminals  
 Courtesy of Chrysler Corp.

## SELF-DIAGNOSTIC TESTS

NOTE: Connector and terminal identification illustrations in following tests are provided courtesy of Chrysler Corp.

NOTE: For connector terminal identification in following tests, see CONNECTOR IDENTIFICATION under DIAGNOSIS & TESTING. For wire color and terminal identification, see WIRING DIAGRAMS.

## TEST 1A

### READING FAULT MESSAGES

Using DRB-II, read fault messages and perform appropriate test listed in FAULT MESSAGES table. If DRB-II displays NO RESPONSE message, perform TEST 23A. If other DRB-II related communication problems exist, see VEHICLE COMMUNICATIONS article in ENGINE PERFORMANCE. If multiple fault messages are present, fault repairs must be performed in order in which they are displayed. If no fault messages are present, perform VERIFICATION TEST VER-1A.

FAULT MESSAGES TABLE

Fault Message	Perform Test
CONTROLLER FAILURE .....	2A
"G" SWITCH NOT PROCESSABLE .....	3A
HYDRAULIC FAILURE .....	4A
LEFT FRONT INLET VALVE .....	5A
LEFT FRONT OUTLET VALVE .....	6A
LEFT FRONT SENSOR CIRCUIT FAILURE .....	7A
LEFT FRONT SENSOR CONTINUITYK25 MPH .....	7A
LEFT FRONT SENSOR CONTINUITYJ25 MPH .....	7A
LEFT FRONT SENSOR SIGNAL MISSING .....	7A
LEFT FRONT WHEEL SPEED COMPARISON .....	7A
REAR INLET VALVE .....	9A
REAR OUTLET VALVE .....	10A
LEFT REAR SENSOR CIRCUIT FAILURE .....	11A
LEFT REAR SENSOR CONTINUITYK25 MPH .....	11A
LEFT REAR SENSOR CONTINUITYJ25 MPH .....	11A
LEFT REAR SENSOR SIGNAL MISSING .....	11A
LEFT REAR WHEEL SPEED COMPARISON .....	11A
MAIN RELAY/POWER CIRCUIT FAILURE .....	13A
PEDAL TRAVEL SENSOR CIRCUIT .....	14A
PUMP MOTOR CIRCUIT NOT WORKING PROPERLY .....	15A
RIGHT FRONT INLET VALVE .....	16A
RIGHT FRONT OUTLET VALVE .....	17A
RIGHT FRONT CIRCUIT FAILURE .....	18A
RIGHT FRONT SENSOR CONTINUITYK25 MPH .....	18A
RIGHT FRONT SENSOR CONTINUITYJ25 MPH .....	18A
RIGHT FRONT REAR SENSOR SIGNAL MISSING .....	18A
RIGHT FRONT WHEEL SPEED COMPARISON .....	18A
RIGHT REAR SENSOR CIRCUIT FAILURE .....	20A
RIGHT REAR SENSOR CONTINUITYK25 MPH .....	20A
RIGHT REAR SENSOR CONTINUITYJ25 MPH .....	20A
RIGHT REAR SENSOR SIGNAL MISSING .....	20A
RIGHT REAR WHEEL SPEED COMPARISON .....	20A
ABS WARNING LAMP ILLUMINATION PROBLEM .....	22A
NO RESPONSE .....	23A

## TEST 2A

## CONTROLLER FAILURE

If DRB-II displays CONTROLLER FAILURE, replace Controller Anti-Lock Brake (CAB). Perform VERIFICATION TEST VER-1A.

### TEST 3A

#### "G" SWITCH NOT PROCESSABLE

1) Ensure "G" switch sensor assembly is properly installed. If not properly installed, repair as necessary and perform VERIFICATION TEST VER-1A. If "G" switch is properly installed, turn ignition off. Disconnect and inspect CAB 55-pin connector and "G" switch sensor 3-pin connector. Repair connectors as necessary.

2) Turn ignition on. With DRB-II in voltmeter mode, probe "G" switch connector terminals individually. If voltage is present, repair short to voltage in that "G" switch circuit. Perform VERIFICATION TEST VER-1A. If voltage is not present at any terminals, go to next step.

3) Turn ignition off. With DRB-II in ohmmeter mode, probe "G" switch connector terminals individually with remaining lead connected to chassis ground. If resistance at any terminal is less than 5 ohms, repair short to ground in that circuit. Perform VERIFICATION TEST VER-1A.

4) If resistance at each terminal is more than 5 ohms, connect jumper wire between ground and "G" switch terminals No. 1-3. Check for continuity to ground on CAB terminals No. 25, 26 and 43. If continuity to ground does not exist, repair open in that circuit. Perform VERIFICATION TEST VER-1A. If continuity to ground exists, replace CAB. Perform VERIFICATION TEST VER-1A.

### TEST 4A

#### HYDRAULIC FAILURE

1) Inspect brake system for hydraulic leaks, and repair as necessary. If brake system is okay, using DRB-II, read fault messages. If DRB-II displays PUMP/MOTOR NOT WORKING PROPERLY, perform TEST 15A. If DRB-II displays PEDAL TRAVEL SENSOR CIRCUIT, perform TEST 14A. If DRB-II does not display PUMP/MOTOR NOT WORKING PROPERLY or PEDAL TRAVEL SENSOR CIRCUIT, using DRB-II, erase fault messages.

2) Using DRB-II, monitor read faults display for 4 minutes. If any fault messages are displayed, perform TEST 1A. If no fault messages are displayed, depress brake pedal and hold down until instructed to release it. Using DRB-II, actuate hydraulic valve test. Release brake pedal.

3) If brake pedal came back up, perform TEST 14A. If brake pedal dropped all the way to the floor or there were not 3 slight drops in the brake pedal, perform TEST 4B. If the brake pedal did not come back up at end of test, replace pump/motor assembly. If the brake pedal did come back up at end of test, replace CAB. If CAB has already been replaced, replace HCU. Perform VERIFICATION TEST VER-1A.

### TEST 4B

#### HYDRAULIC FAILURE

Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Disconnect and inspect hydraulic unit 10-pin connector. Repair connector as necessary. If terminals of both connectors are not



pushed out, damaged or improperly wired, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A.

## **TEST 5A**

### **LEFT FRONT INLET VALVE**

1) Disconnect and inspect hydraulic unit 10-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe terminal No. 4 (White/Light Green wire) of hydraulic unit connector. If voltage is present, repair short to voltage in White/Light Green wire. Perform VERIFICATION TEST VER-1A.

2) If voltage is not present, turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. With DRB-II in ohmmeter mode, probe terminal No. 4 (White/Light Green wire) of hydraulic unit connector. If resistance is less than 5 ohms, repair short to ground in White/Light Green wire.

3) If resistance is more than 5 ohms, check resistance of White/Light Green wire between terminals No. 20 of CAB connector and No. 4 of hydraulic unit connector using an external ohmmeter. If resistance is more than 5 ohms, repair open in White/Light Green wire. Perform VERIFICATION TEST VER-1A.

4) If resistance is less than 5 ohms, measure resistance of left front inlet valve. If resistance is 5-8 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 5-8 ohms, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A.

## **TEST 6A**

### **LEFT FRONT OUTLET VALVE**

1) Disconnect and inspect hydraulic unit 10-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe terminal No. 9 (Dark Green/Black wire) of hydraulic unit connector. If voltage is present, repair short to voltage in Dark Green/Black wire. Perform VERIFICATION TEST VER-1A.

2) If voltage is not present, turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. With DRB-II in ohmmeter mode, probe terminal No. 9 (Dark Green/Black wire) of hydraulic unit connector. If resistance is less than 5 ohms, repair short to ground in Dark Green/Black wire.

3) If resistance is more than 5 ohms, check resistance of Dark Green/Black wire between terminals No. 2 of CAB connector and No. 9 of hydraulic unit connector using an external ohmmeter. If resistance is more than 5 ohms, repair open in Dark Green/Black wire. Perform VERIFICATION TEST VER-1A.

4) If resistance is less than 5 ohms, measure resistance of left front outlet valve. If resistance is not 3-5 ohms, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A. If resistance is 3-5 ohms, replace CAB. Perform VERIFICATION TEST VER-1A.

## **TEST 7A**

### **LEFT FRONT SENSOR CIRCUIT FAILURE**

1) Using DRB-II, read and record all speed sensor fault messages. If DRB-II does not display LEFT FRONT SENSOR CIRCUIT FAILURE, perform TEST 8A. If DRB-II displays LEFT FRONT SENSOR CIRCUIT FAILURE, inspect left front wheel speed sensor for damage. If sensor is damaged, repair or replace sensor as necessary. Perform

VERIFICATION TEST VER-1A. If sensor is okay, turn ignition off.

2) Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe terminal No. 48 (Red wire) of CAB connector. If voltage is present, repair short to battery in Red wire. Perform VERIFICATION TEST VER-1A.

3) If voltage is not present, turn ignition off. With DRB-II in ohmmeter mode, probe terminal No. 48 (Red wire) of CAB connector. If resistance is less than 5 ohms, repair short to ground in Red wire. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

4) Using an external ohmmeter, check resistance between terminal No. 48 (Red wire) and No. 30 (Red/Dark Blue wire) of CAB connector. If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 900-1300 ohms, disconnect and inspect left front wheel speed sensor connector.

5) Using an external ohmmeter, check resistance between left wheel speed sensor connector terminals. If resistance is not 900-1300 ohms, replace wheel speed sensor. Perform VERIFICATION TEST VER-1A. If resistance is 900-1300 ohms, check resistance of Red wire between terminal No. 48 of CAB connector and No. 1 of left front wheel speed sensor connector using an external ohmmeter.

6) If resistance is more than 5 ohms, repair open Red wire. Perform VERIFICATION TEST VER-1A. If resistance is less than 5 ohms, repair open Red/Dark Blue wire. Perform VERIFICATION TEST VER-1A.

## **TEST 8A**

### **LEFT FRONT SENSOR**

1) Inspect left front wheel speed sensor for damage. Repair or replace sensor as necessary. Perform VERIFICATION TEST VER-1A. If sensor is okay, check left front sensor tone (pulse) ring for damage. Repair or replace tone ring as necessary. Perform VERIFICATION TEST VER-1A. If tone ring is okay, inspect left front wheel speed sensor wiring harness for damage.

2) Repair or replace wiring as necessary. Perform VERIFICATION TEST VER-1A. If wiring harness is okay, disconnect and inspect left front wheel speed sensor connector. Repair connector as necessary. Using an external ohmmeter, check resistance between left front wheel speed sensor connector terminals.

3) If resistance is not 900-1300 ohms, replace wheel speed sensor. Perform VERIFICATION TEST VER-1A. If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A.

NOTE: If excessive axle deflection occurs on extremely bumpy surfaces or during off road use, it is possible for a wheel speed sensor to set a code.

## **TEST 9A**

### **REAR INLET VALVE**

1) Disconnect and inspect hydraulic unit 10-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe terminal No. 4 (White/Black wire on Cherokee and Wrangler or White/Red wire on Grand Cherokee and Grand Wagoneer) of hydraulic unit connector. If voltage is present, repair short to voltage in White/Black or White/Red wire. Perform VERIFICATION TEST VER-1A.

2) If voltage is not present, turn ignition off. Disconnect

and inspect CAB 55-pin connector. Repair connector as necessary. With DRB-II in ohmmeter mode, probe terminal No. 4 of hydraulic unit connector. If resistance is less than 5 ohms, repair short to ground in White/Black or White/Red wire. Perform VERIFICATION TEST VER-1A.

3) If resistance is less than 5 ohms, check resistance of between terminal No. 54 of CAB connector and No. 4 of hydraulic unit connector using an external ohmmeter. If resistance is more than 5 ohms, repair open in White/Black or White/Red wire. Perform VERIFICATION TEST VER-1A.

4) Using an external ohmmeter, check resistance between terminals No. 4 and 5 of hydraulic control unit pigtail connector. If resistance is not 5-8 ohms, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A. If resistance is 5-8 ohms, replace CAB. Perform VERIFICATION TEST VER-1A.

## **TEST 10A**

### **REAR OUTLET VALVE**

1) Disconnect and inspect hydraulic unit 10-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe terminal No. 7 (Dark Green/Orange wire) of hydraulic unit connector. If voltage is present, repair short to voltage in Dark Green/Orange wire. Perform VERIFICATION TEST VER-1A.

2) If voltage is not present, turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. With DRB-II in ohmmeter mode, probe terminal No. 7 (Dark Green/Orange wire) of hydraulic unit connector. If resistance is less than 5 ohms, repair short to ground in Dark Green/Orange wire.

3) If resistance is more than 5 ohms, check resistance of Dark Green/Orange wire between terminal No. 36 of CAB connector and No. 7 of hydraulic unit connector using an external ohmmeter. If resistance is more than 5 ohms, repair open Dark Green/Orange wire. Perform VERIFICATION TEST VER-1A. If resistance is less than 5 ohms, go to next step.

4) Using an external ohmmeter, check resistance between terminals No. 7 and 10 of hydraulic control unit connector. If resistance is not 3-5 ohms, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A. If resistance is 3-5 ohms, replace CAB. Perform VERIFICATION TEST VER-1A.

## **TEST 11A**

### **LEFT REAR SENSOR CIRCUIT FAILURE**

1) Using DRB-II, read and record all speed sensor fault messages. If DRB-II does not display LEFT REAR SENSOR CIRCUIT FAILURE, perform TEST 12A. If DRB-II displays LEFT REAR SENSOR CIRCUIT FAILURE, inspect left rear wheel speed sensor for damage. If sensor is damaged, repair or replace sensor as necessary. Perform VERIFICATION TEST VER-1A. If sensor is okay, turn ignition off.

2) Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe terminal No. 46 (Light Green wire) of CAB connector. If voltage is present, perform TEST 11B.

3) If voltage is not present, turn ignition off. With DRB-II in ohmmeter mode, probe terminal No. 46 (Light Green wire) of CAB connector. If resistance is less than 5 ohms, perform TEST 11C. If resistance is more than 5 ohms, using an external ohmmeter, check resistance between terminal No. 46 (Light Green wire) and No. 28 (Light Green/Dark Blue wire) of CAB connector.

4) If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 900-1300 ohms, disconnect and inspect left rear wheel speed sensor connector. Using an external ohmmeter, check resistance between left rear wheel speed sensor connector terminals. If resistance is not 900-1300 ohms, replace wheel speed sensor. Perform VERIFICATION TEST VER-1A.

5) If resistance is 900-1300 ohms, connect a jumper wire between terminal No. 46 (Light Green wire) of CAB connector and ground. With DRB-II in ohmmeter mode, probe Light Green wire of left rear wheel speed sensor connector. If resistance is more than 5 ohms, perform TEST 11D. If resistance is less than 5 ohms, perform TEST 11E.

## **TEST 11B**

### **LEFT REAR SENSOR CIRCUIT FAILURE**

1) On Cherokee and Wrangler, repair short to battery voltage in Light Green wire. Perform VERIFICATION TEST VER-1A. On Grand Cherokee and Grand Wagoneer, disconnect and inspect Black ABS 8-pin disconnect connector. Connector is located behind left side kick panel. Repair connector as necessary. With DRB-II in voltmeter mode, probe Light Green wire of ABS disconnect connector.

2) If voltage is not present, repair short to battery voltage in Light Green wire between wheel speed sensor and CAB disconnect connector. Perform VERIFICATION TEST VER-1A. If voltage is present, repair short to battery voltage in Light Green wire between ABS disconnect connector and CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.

## **TEST 11C**

### **LEFT REAR SENSOR CIRCUIT FAILURE**

1) On Cherokee and Wrangler, repair short to ground in Light Green wire. Perform VERIFICATION TEST VER-1A. On Grand Cherokee and Grand Wagoneer, disconnect and inspect Black CAB 8-pin disconnect connector. Connector is located behind left side kick panel. Repair connector as necessary. With DRB-II in ohmmeter mode, probe Light Green wire of ABS disconnect connector.

2) If resistance is more than 5 ohms, repair short to ground in Light Green wire between wheel speed sensor and ABS disconnect connector. Perform VERIFICATION TEST VER-1A. If resistance is less than 5 ohms, repair short to ground in Light Green wire between ABS disconnect connector and CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.

## **TEST 11D**

### **LEFT REAR SENSOR CIRCUIT FAILURE**

1) On Cherokee and Wrangler, repair open in Light Green wire. Perform VERIFICATION TEST VER-1A. On Grand Cherokee and Grand Wagoneer, disconnect and inspect Black CAB 8-pin disconnect connector. Connector is located behind left side kick panel. Repair connector as necessary. With DRB-II in ohmmeter mode, probe Light Green wire of ABS disconnect connector.

2) If resistance is less than 5 ohms, repair open in Light Green wire between wheel speed sensor and ABS disconnect connector. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open in Light Green wire between ABS disconnect connector and

CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.

## **TEST 11E**

### **LEFT REAR SENSOR CIRCUIT FAILURE**

1) On Cherokee and Wrangler, repair open in Light Green/Dark Blue wire. Perform VERIFICATION TEST VER-1A. On Grand Cherokee and Grand Wagoneer, disconnect and inspect Black ABS 8-pin disconnect connector. Connector is located behind left side kick panel. Repair connector as necessary. Connect a jumper wire between terminal No. 28 (Light Green/Dark Blue wire) of CAB connector and ground. With DRB-II in ohmmeter mode, probe Light Green/Dark Blue wire of ABS disconnect connector.

2) If resistance is less than 5 ohms, repair open in Light Green/Dark Blue wire between wheel speed sensor and ABS disconnect connector. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open in Light Green/Dark Blue wire between ABS disconnect connector and CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.

## **TEST 12A**

### **LEFT REAR SENSOR**

1) Inspect left rear wheel speed sensor. If speed sensor is damaged, contaminated or loose, repair or replace speed sensor as necessary. Perform VERIFICATION TEST VER-1A. If speed sensor is okay, inspect left rear tone (pulse) ring for damaged teeth or excessive runout. Runout should not exceed .003" (.08 mm). Repair or replace tone ring as necessary. Perform VERIFICATION TEST VER-1A.

2) If tone ring is okay, using a feeler gauge, check left rear wheel sensor-to-tone ring clearance. If clearance is not .036-.050" (.91-1.27 mm), repair as necessary. If clearance is .036-.050" (.91-1.27 mm), inspect left rear wheel speed sensor inspect left front wheel speed sensor wiring harness for damage.

3) Repair or replace wiring as necessary. If wiring harness is okay, disconnect and inspect left rear wheel speed sensor connector. Repair connector as necessary. Using an external ohmmeter, check resistance between left rear wheel speed sensor connector terminals.

4) If resistance is not 900-1300 ohms, replace wheel speed sensor. Perform VERIFICATION TEST VER-1A. If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A.

NOTE: If excessive axle deflection occurs on extremely bumpy surfaces or during off road use, it is possible for a wheel speed sensor to set a code.

## **TEST 13A**

### **MAIN RELAY/POWER CIRCUIT FAILURE**

1) Check ABS system fuse in Power Distribution Center (PDC). If fuse is not okay, perform TEST 13B. If fuse is okay, go to next step.

2) Check if charging system is overcharging. If charging system is operating properly, go to next step. If charging system is not operating properly, repair as necessary. Perform VERIFICATION TEST VER-1A.

3) Temporarily replace ABS main relay with another 5-terminal relay from PDC. Using DRB-II, erase ABS fault messages. Cycle ignition off and on. Using DRB-II, read ABS fault messages. If MAIN RELAY/POWER CIRCUIT FAILURE message is displayed, go to next step. If fault is not displayed, replace ABS main relay. Perform VERIFICATION TEST VER-1A.

4) Install replacement 5-terminal relay back into PDC, leaving ABS main relay disconnected (removed). With DRB-II in voltmeter mode, probe fused battery feed Red/Dark Green wire (Red/Light Green wire on Grand Cherokee and Grand Wagoneer) at ABS main relay socket. If voltage is more than 9 volts, go to next step. If voltage is less than 9 volts, repair open Red/Dark Green wire (Red/Light Green on Grand Cherokee and Grand Wagoneer) wire to ABS fuse in PDC. Perform VERIFICATION TEST VER-1A.

5) Turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Ensure ABS main relay is still disconnected. Using an external ohmmeter, check continuity of Pink (Pink/Dark Blue on Grand Cherokee and Grand Wagoneer) wire between CAB connector terminal No. 34 and ABS main relay socket terminal "C". If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Pink (Pink/Dark Blue on Grand Cherokee and Grand Wagoneer) wire to ABS main relay. Perform VERIFICATION TEST VER-1A.

6) Check continuity of Gray/Yellow wire between CAB connector terminal No. 3 and ABS main relay socket terminal "B". If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Gray/Yellow wire to ABS main relay. Perform VERIFICATION TEST VER-1A.

7) Check continuity of Gray/Yellow wire between CAB connector terminal No. 33 and ABS main relay socket terminal "B". If resistance is less than 5 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open Gray/Yellow wire to ABS main relay. Perform VERIFICATION TEST VER-1A.

## **TEST 13B**

### **MAIN RELAY/POWER CIRCUIT FAILURE**

1) Remove ABS system fuse from Power Distribution Center (PDC). Remove ABS main relay from PDC, and inspect connector. Repair connector as necessary. With DRB-II in ohmmeter mode, probe fused battery feed Red/Dark Green wire (Red/Light Green wire on Grand Cherokee and Grand Wagoneer or Red/Dark Blue wire on Wrangler) at ABS main relay socket. If resistance is less than 5 ohms, repair Red/Dark Green wire (Red/Light Green wire on Grand Cherokee and Grand Wagoneer or Red/Dark Blue wire on Wrangler) for a short to ground. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

2) Remove ABS pump/motor relay from PDC, and inspect connector. Repair connector as necessary. Using an external ohmmeter, measure resistance of ABS pump/motor relay coil. See Fig. 16. If resistance is 35-65 ohms, go to next step. If resistance is not 35-65 ohms, replace ABS pump/motor relay. Perform VERIFICATION TEST VER-1A.

3) Disconnect hydraulic control unit 10-pin connector. With DRB-II in ohmmeter mode, probe Gray/Yellow wire (Gray/Pink wire on Grand Cherokee and Grand Wagoneer) at ABS main relay socket terminal "B". If resistance is less than 5 ohms, repair Gray/Yellow wire (Gray/Pink wire on Grand Cherokee and Grand Wagoneer) for a short to ground. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

4) Reconnect all disconnected components. Install a new ABS fuse in PDC and cycle ignition off and on. Inspect ABS fuse in PDC. If fuse is okay (does not blow), perform TEST 13C. If fuse is not okay

(blows), replace hydraulic control unit. Perform VERIFICATION TEST VER-1A.

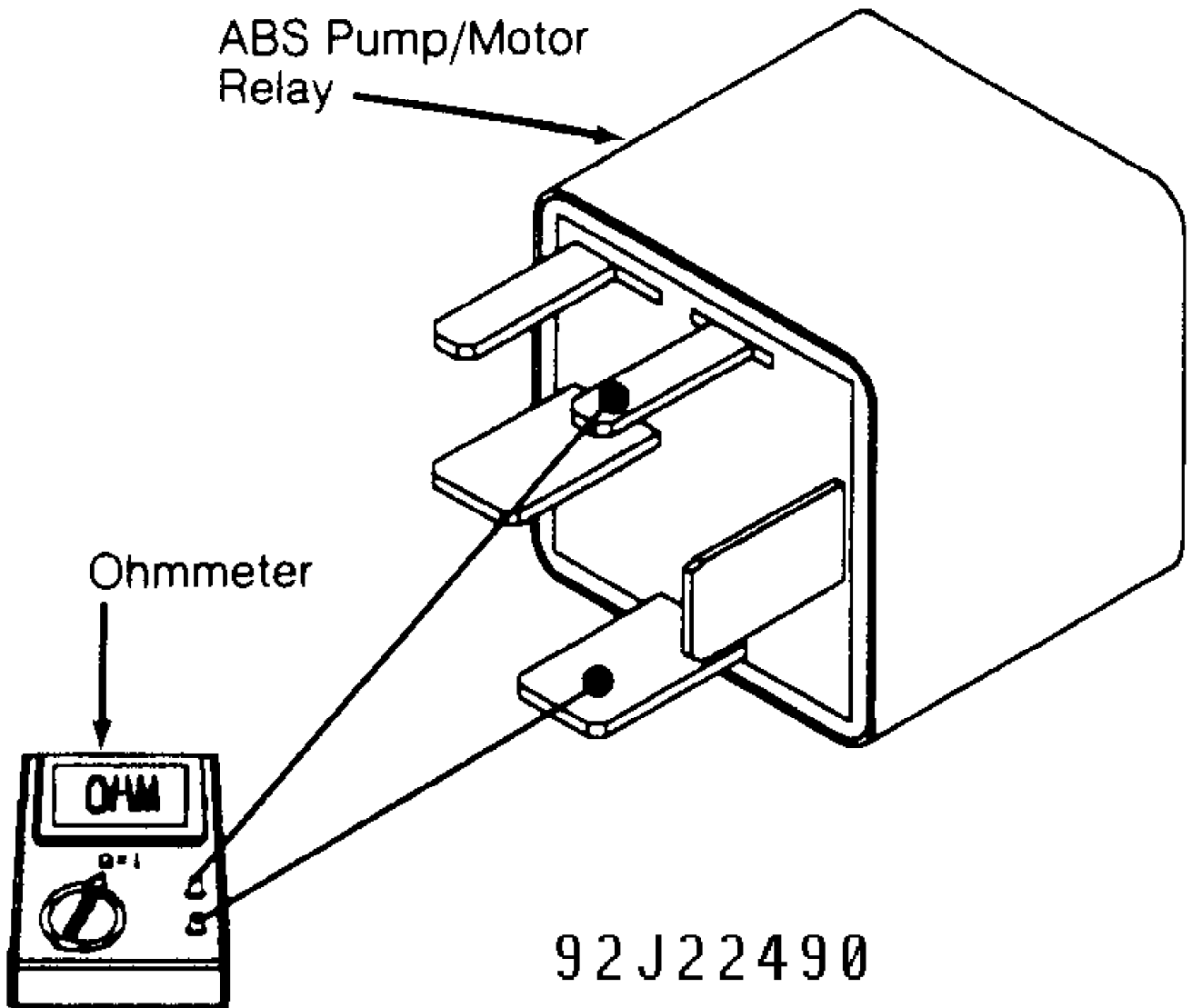


Fig. 16: Measuring ABS Pump/Motor Relay Resistance

### TEST 13C

#### MAIN RELAY/POWER CIRCUIT FAILURE

1) Ensure DRB-II is NOT in TEVES ABS DIAGNOSTIC MODE. Road test vehicle, making several ABS stops. Inspect ABS fuse in PDC. If fuse is okay (does not blow), ABS system is operating properly at this time. Perform VERIFICATION TEST VER-1A.

2) If fuse is not okay (blows), inspect ABS wiring harness for damage and repair as necessary. Perform VERIFICATION TEST VER-1A. If wiring harness is okay, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A.

### TEST 14A

## PEDAL TRAVEL SENSOR CIRCUIT

1) Inspect pedal travel sensor connector. Sensor is located on right side of brake booster. If connector is disconnected and/or damaged, repair connector as necessary and perform VERIFICATION TEST VER-1A. If connector is properly connected and NOT damaged, go to next step.

2) Turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Turn ignition on. Disconnect and inspect pedal travel sensor connector. Repair connector as necessary. With DRB-II in voltmeter mode, probe Gray/Light Blue wire at sensor connector. If no voltage is present, go to next step. If voltage is present, repair Gray/Light Blue wire for a short to battery voltage. Perform VERIFICATION TEST VER-1A.

3) Turn ignition off. With DRB-II in ohmmeter mode, probe Gray/Light Blue wire at pedal travel sensor connector. If resistance is less than 5 ohms, repair Gray/Light Blue wire for a short to ground. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

4) Using an external ohmmeter, measure resistance between CAB connector terminal No. 16 and pedal travel sensor connector Gray/Light Blue wire. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Gray/Light Blue wire to pedal travel sensor. Perform VERIFICATION TEST VER-1A.

5) Using an external ohmmeter, measure resistance between CAB connector terminal No. 41 and pedal travel sensor connector Red/Black wire. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Red/Black wire to pedal travel sensor. Perform VERIFICATION TEST VER-1A.

6) Remove pedal travel sensor from brake booster. Check if sensor plunger cap color matches color dot on booster (near sensor). If colors match, go to next step. If colors do not match, replace pedal travel sensor. Perform VERIFICATION TEST VER-1A.

7) Using an external ohmmeter, measure resistance of pedal travel sensor while slowly depressing sensor plunger. If sensor resistance is as specified, replace CAB. See PEDAL TRAVEL SENSOR RESISTANCE table. Perform VERIFICATION TEST VER-1A. If sensor resistance is not as specified, replace pedal travel sensor. Perform VERIFICATION TEST VER-1A.

PEDAL TRAVEL SENSOR RESISTANCE TABLE

Plunger Position	Ohms
Step 1 (Rest) .....	236-262
Step 2 .....	414-458
Step 3 .....	534-592
Step 4 .....	655-725
Step 5 .....	776-858
Step 6 .....	980-1084
Step 7 .....	Infinity

## TEST 15A

### PUMP MOTOR CIRCUIT NOT WORKING PROPERLY

1) Inspect ABS pump/motor fuse from Power Distribution Center (PDC). If fuse is okay, go to next step. If fuse is not okay (blown), perform TEST 15B.

2) Remove ABS pump/motor relay from PDC, and inspect



connector. Repair connector as necessary. With DRB-II in voltmeter mode, probe Red/Dark Green wire (Red/Dark Blue wire on Grand Cherokee and Grand Wagoneer or Red/Brown wire on Wrangler) at ABS pump/motor relay socket terminal "B". If voltage is more than 9 volts, go to next step. If voltage is less than 9 volts, repair open Red/Dark Green wire (Red/Dark Blue wire on Grand Cherokee and Grand Wagoneer or Red/Brown wire on Wrangler) to ABS pump/motor relay.

3) Connect a jumper wire between Red/Dark Green wire and Tan/Black wire (Brown/White wire and Red/Dark Blue wire on Grand Cherokee and Grand Wagoneer or Tan wire and Red/Brown wire on Wrangler) at ABS pump/motor relay socket terminals "B" and "D". Turn ignition on. Inspect ABS pump/motor fuse. If fuse is okay (does not blow), go to next step. If fuse is not okay (blows), perform TEST 15B.

4) Listen for ABS pump/motor operation. If ABS pump/motor is running, go to next step. If ABS pump/motor is not running, perform TEST 15C.

5) Turn ignition off. Remove jumper wire. With DRB-II in ohmmeter mode, probe Gray/Yellow wire (Gray/Pink wire on Grand Cherokee and Grand Wagoneer) at ABS pump/motor relay socket. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Gray/Yellow wire (Gray/Pink wire on Grand Cherokee and Grand Wagoneer) wire between ABS pump/motor relay socket and ABS main relay. Perform VERIFICATION TEST VER-1A.

6) Using an external ohmmeter, measure resistance of ABS pump/motor relay coil terminals No. 85 and 86. See Fig. 16. If resistance is 35-65 ohms, go to next step. If resistance is not 35-65 ohms, replace ABS pump/motor relay. Perform VERIFICATION TEST VER-1A.

7) Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe Gray wire at ABS pump/motor relay socket. If no voltage is present, go to next step. If any voltage is present, repair Gray wire for a short to battery voltage. Perform VERIFICATION TEST VER-1A.

8) Turn ignition off. With DRB-II in ohmmeter mode, probe Gray wire at ABS pump/motor relay socket. If resistance is less than 5 ohms, repair Gray wire for a short to ground. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

9) Using an external ohmmeter, measure resistance between CAB connector terminal No. 15 and ABS pump/motor relay socket Gray wire. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Gray wire to relay socket. Perform VERIFICATION TEST VER-1A.

10) Turn ignition off. Reinstall ABS pump/motor relay in PDC. Apply battery voltage to CAB connector terminal No. 15, and go to next step.

11) Ensure ignition is off. With DRB-II in voltmeter mode, probe Tan/Black wire (Brown/White wire on Grand Cherokee and Grand Wagoneer or Tan wire on Wrangler) at ABS pump/motor 4-pin harness connector. If voltage is more than 9 volts, perform TEST 15D. If voltage is less than 9 volts, replace ABS pump/motor relay. Perform VERIFICATION TEST VER-1A.

## **TEST 15B**

### **PUMP MOTOR CIRCUIT NOT WORKING PROPERLY**

1) Remove ABS pump/motor relay (if installed) from Power Distribution Center (PDC). Remove jumper wire from ABS pump/motor relay socket (if installed). Turn ignition off, and go to next step.

2) With DRB-II in ohmmeter mode, probe Tan/Black wire (Brown/White wire on Grand Cherokee and Grand Wagoneer or Tan wire on Wrangler) at ABS pump/motor relay socket. If resistance is less than 5 ohms, repair Tan/Black wire (Brown/White wire on Grand Cherokee and

Grand Wagoneer or Tan wire on Wrangler) for a short to ground. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

3) Using an external ohmmeter, check ABS pump/motor relay diode. Attach ohmmeter positive and negative leads as shown. See Fig. 17. If continuity exists, replace ABS pump/motor relay. Perform VERIFICATION TEST VER-1A. If no continuity exists, replace ABS pump/motor assembly. Perform VERIFICATION TEST VER-1A.

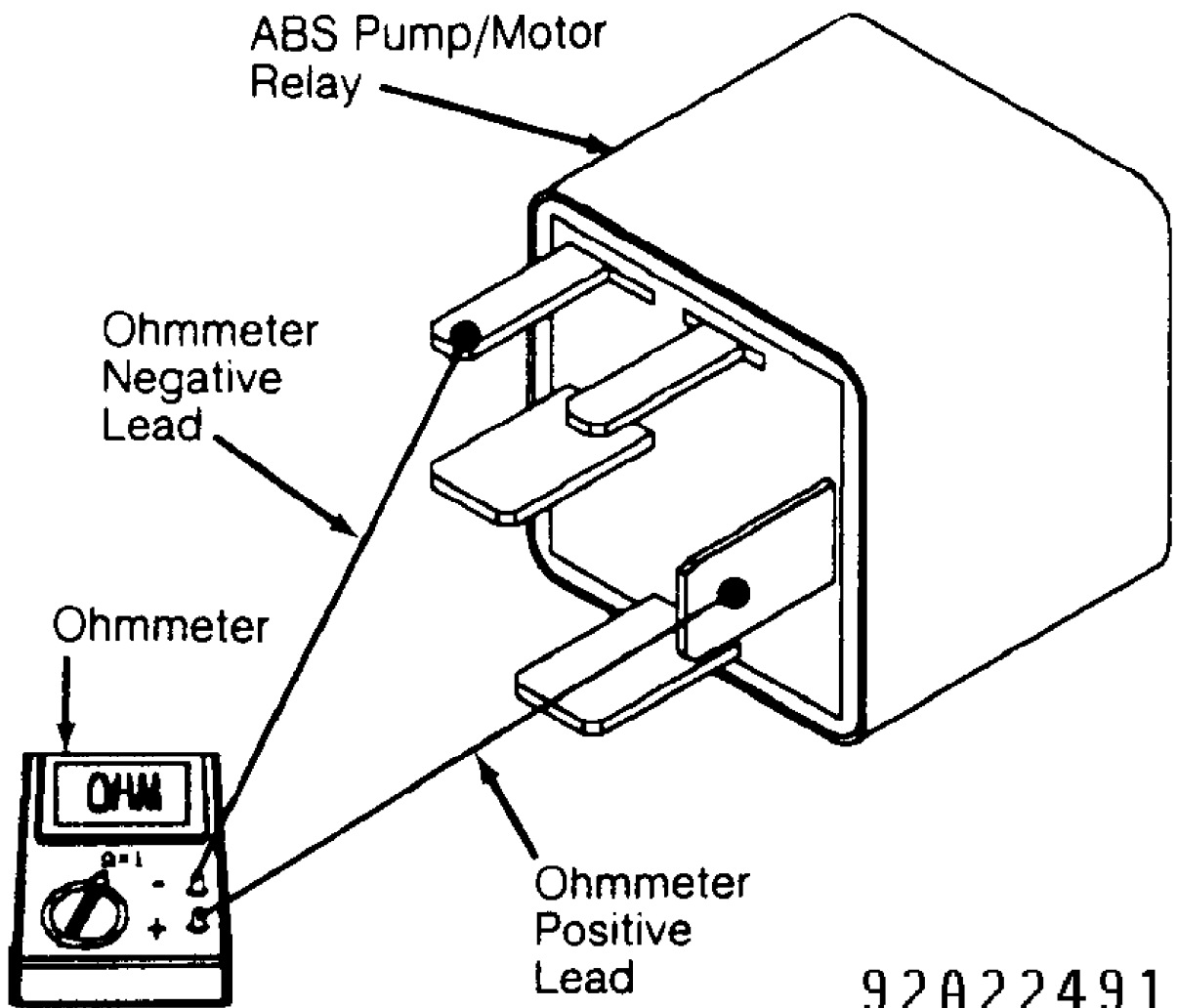


Fig. 17: Checking ABS Pump/Motor Relay Diode

## TEST 15C

### PUMP MOTOR CIRCUIT NOT WORKING PROPERLY

1) Disconnect ABS pump/motor 4-pin connector at hydraulic control unit. Ensure jumper wire is still connected between Red/Dark Green wire and Tan/Black wire (Brown/White wire and Red/Dark Blue wire on Grand Cherokee and Grand Wagoneer or Tan wire and Red/Brown wire on Wrangler) at ABS pump/motor relay socket.

2) With DRB-II in voltmeter mode, probe Tan/Black wire (Brown/White wire on Grand Cherokee and Grand Wagoneer or Tan wire on

Wrangler) at ABS pump/motor 4-pin harness connector. If voltage is more than 9 volts, go to next step. If voltage is less than 9 volts, repair open Tan/Black wire (Brown/White wire on Grand Cherokee and Grand Wagoneer or Tan wire on Wrangler) to 4-pin harness connector. Perform VERIFICATION TEST VER-1A.

3) Turn ignition off. With DRB-II in ohmmeter mode, probe Black/Tan ground wire (Black ground wire on Grand Cherokee and Grand Wagoneer) at ABS pump/motor 4-pin harness connector. If resistance is less than 5 ohms, replace ABS pump/motor assembly. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open in Black/Tan ground wire (Black ground wire on Grand Cherokee and Grand Wagoneer). Perform VERIFICATION TEST VER-1A.

## TEST 15D

### PUMP MOTOR CIRCUIT NOT WORKING PROPERLY

1) Using an external ohmmeter, measure resistance of ABS pump/motor speed sensor. See Fig. 18. If sensor resistance is 10-35 ohms, go to next step. If resistance is not 10-35 ohms, replace ABS pump/motor assembly. Perform VERIFICATION TEST VER-1A.

2) Turn ignition on. With DRB-II in voltmeter mode, probe Tan wire (Light Green/Brown wire on Wrangler) at ABS pump/motor 4-pin harness connector. If any voltage is present, repair ABS pump/motor speed sensor Tan wire (Light Green wire on Wrangler) for a short to battery voltage. Perform VERIFICATION TEST VER-1A. If no voltage is present, go to next step.

3) With DRB-II in voltmeter mode, probe Dark Blue wire (Brown wire on Wrangler) at ABS pump/motor 4-pin harness connector. If any voltage is present, repair ABS pump/motor speed sensor Dark Blue wire (Brown wire on Wrangler) for a short to battery voltage. Perform VERIFICATION TEST VER-1A. If no voltage is present, go to next step.

4) With DRB-II in ohmmeter mode, probe Tan wire (Light Green/Brown wire on Wrangler) at ABS pump/motor 4-pin harness connector. If resistance is less than 5 ohms, repair ABS pump/motor speed sensor Tan wire (Light Green/Brown wire on Wrangler) for a short to ground. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

5) With DRB-II in ohmmeter mode, probe Dark Blue wire (Brown wire on Wrangler) at ABS pump/motor 4-pin harness connector. If resistance is less than 5 ohms, repair ABS pump/motor speed sensor Dark Blue wire (Brown wire on Wrangler) for a short to ground. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, go to next step.

6) Using an external ohmmeter, measure resistance of Tan wire (Light Green/Brown wire on Wrangler) between CAB connector terminal No. 49 and ABS pump/motor 4-pin harness connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open ABS pump/motor speed sensor Tan wire (Light Green/Brown wire on Wrangler). Perform VERIFICATION TEST VER-1A.

7) Using an external ohmmeter, measure resistance of Dark Blue wire (Brown wire on Wrangler) between CAB connector terminal No. 31 and ABS pump/motor 4-pin harness connector. If resistance is less than 5 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open ABS pump/motor speed sensor Dark Blue wire (Brown wire on Wrangler). Perform VERIFICATION TEST VER-1A.

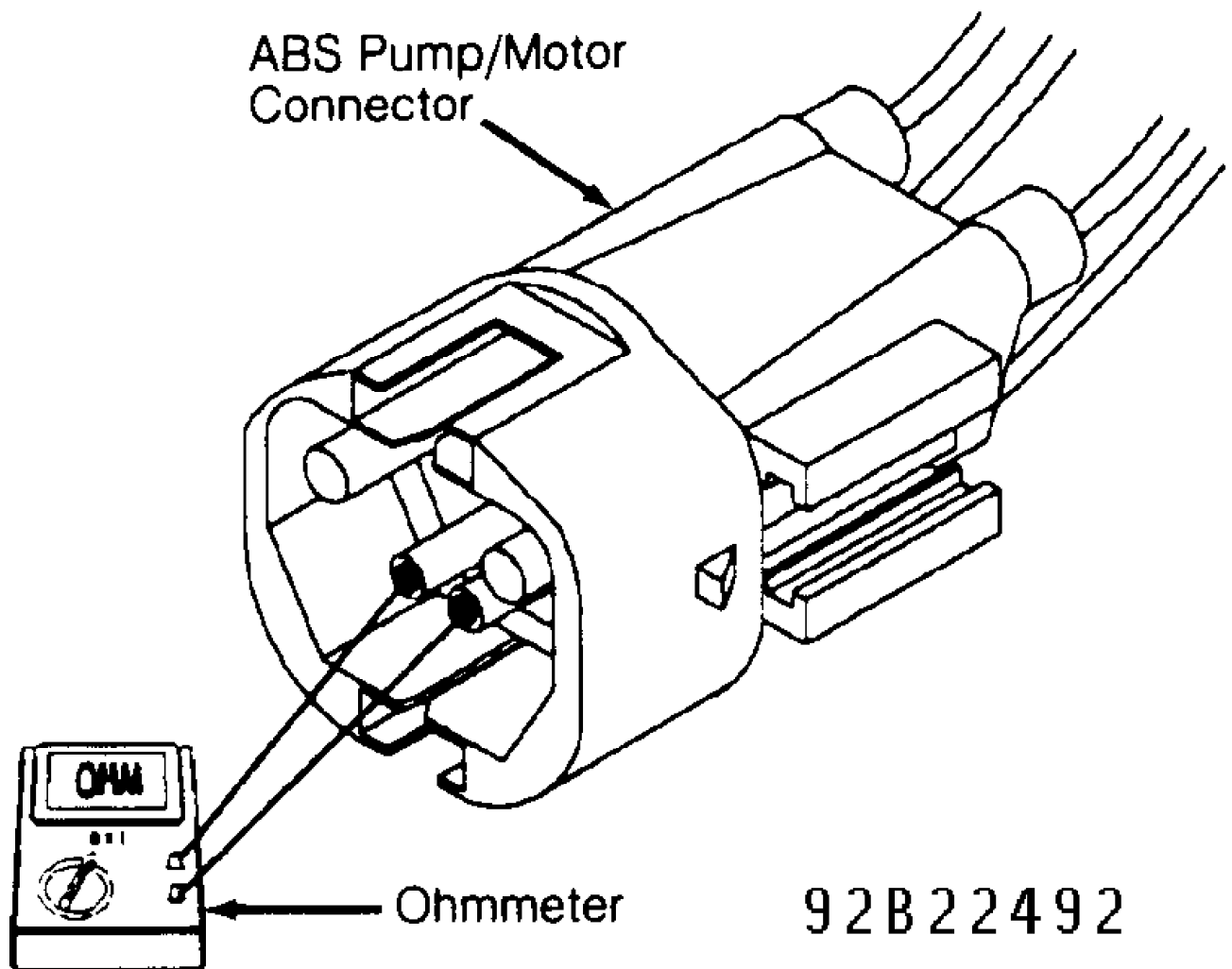


Fig. 18: Checking ABS Pump/Motor Sensor Resistance

## TEST 16A

### RIGHT FRONT INLET VALVE

1) Disconnect and inspect Hydraulic Control Unit (HCU) 10-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe White/Tan wire (White/Orange wire on Grand Cherokee and Grand Wagoneer or White/Yellow wire on Wrangler) at HCU 10-pin harness connector. If no voltage is present, go to next step. If any voltage is present, repair White/Tan wire (White/Orange wire on Grand Cherokee and Grand Wagoneer or White/Yellow wire on Wrangler) for a short to battery power. Perform VERIFICATION TEST VER-1A.

2) Turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. With DRB-II in ohmmeter mode, probe White/Tan wire (White/Orange wire on Grand Cherokee and Grand Wagoneer or White/Yellow wire on Wrangler) at HCU 10-pin harness connector. If resistance is more than 5 ohms, go to next step. If resistance is less than 5 ohms, repair White/Tan wire (White/Orange wire on Grand Cherokee and Grand Wagoneer or White/Yellow wire on Wrangler) for a short to ground. Perform VERIFICATION TEST VER-1A.

3) Using an external ohmmeter, measure resistance of

White/Tan wire (White/Orange wire on Grand Cherokee and Grand Wagoneer or White/Yellow wire on Wrangler) between CAB connector terminal No. 38 and HCU 10-pin harness connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open White/Tan wire (White/Orange wire on Grand Cherokee and Grand Wagoneer or White/Yellow wire on Wrangler). Perform VERIFICATION TEST VER-1A.

4) Using an external ohmmeter, measure resistance of right front inlet valve between terminals No. 3 and 5 at HCU pigtail connector. See Fig. 19. If resistance is 5-8 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 5-8 ohms, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A.

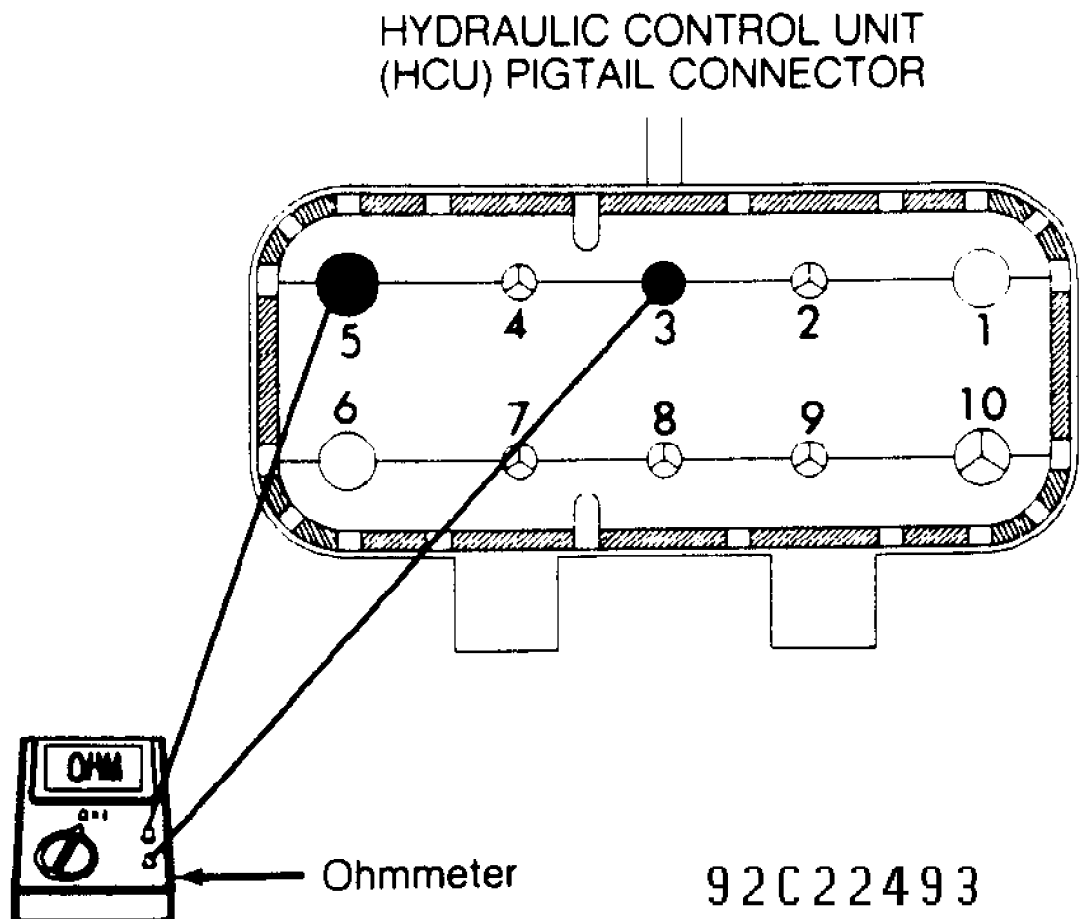


Fig. 19: Checking HCU Right Front Inlet Valve Resistance

## TEST 17A

### RIGHT FRONT OUTLET VALVE

- 1) Disconnect and inspect Hydraulic Control Unit (HCU) 10-pin

connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe Dark Green/White wire at HCU 10-pin harness connector. If no voltage is present, go to next step. If any voltage is present, repair Dark Green/White wire for a short to battery power. Perform VERIFICATION TEST VER-1A.

2) Turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. With DRB-II in ohmmeter mode, probe Dark Green/White wire at HCU 10-pin harness connector. If resistance is more than 5 ohms, go to next step. If resistance is less than 5 ohms, repair Dark Green/White wire for a short to ground. Perform VERIFICATION TEST VER-1A.

3) Using an external ohmmeter, measure resistance of Dark Green/White wire between CAB connector terminal No. 21 and HCU 10-pin harness connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Dark Green/White wire. Perform VERIFICATION TEST VER-1A.

4) Using an external ohmmeter, measure resistance of right front outlet valve between terminals No. 8 and 10 at HCU connector. See Fig. 19. If resistance is 3-5 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 3-5 ohms, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A.

## **TEST 18A**

### **RIGHT FRONT SENSOR CIRCUIT FAILURE**

1) Using DRB-II, read and record all wheel speed sensor faults. If RIGHT FRONT SENSOR CIRCUIT FAILURE message is displayed, go to next step. If message is not displayed, perform TEST 19A.

2) Inspect right front wheel speed sensor for damage. If sensor is okay, go to next step. If sensor is damaged, repair or replace as necessary. Perform VERIFICATION TEST VER-1A.

3) Turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe White wire at CAB connector terminal No. 47. If no voltage is present, go to next step. If any voltage is present, repair White wire for a short to battery power. Perform VERIFICATION TEST VER-1A.

4) Turn ignition off. With DRB-II in ohmmeter mode, probe White wire at CAB connector terminal No. 47. If resistance is more than 5 ohms, go to next step. If resistance is less than 5 ohms, repair White wire for a short to ground. Perform VERIFICATION TEST VER-1A.

5) Using an external ohmmeter, measure resistance of right front wheel speed sensor between White/Dark Blue wire and White wire at CAB connector terminals No. 29 and 47. If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 900-1300 ohms, go to next step.

6) Disconnect right front wheel speed sensor harness connector. Connector is located on right rear corner of engine compartment. Using an external ohmmeter, measure resistance of right front wheel speed sensor at harness connector terminals. If resistance is 900-1300 ohms, go to next step. If resistance is not 900-1300 ohms, replace sensor. Perform VERIFICATION TEST VER-1A.

7) Using an external ohmmeter, measure resistance of White wire between CAB connector terminal No. 47 and right front wheel speed sensor harness connector. If resistance is less than 5 ohms, repair open White/Dark Blue wire. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open White wire. Perform VERIFICATION TEST VER-1A.

## TEST 19A

### RIGHT FRONT SENSOR

1) Inspect right front wheel speed sensor for damage. If sensor is okay, go to next step. If sensor is damaged, repair or replace as necessary. Perform VERIFICATION TEST VER-1A.

2) Inspect right front wheel speed sensor tone (pulse) ring for damaged teeth or excessive runout. Runout should not exceed .003" (.08 mm). Repair or replace tone ring as necessary. Perform VERIFICATION TEST VER-1A. If tone ring is okay, go to next step.

3) Using a feeler gauge, check right front wheel sensor-to-tone ring clearance. If clearance is .036-.050" (.91-1.27 mm), go to next step. If clearance is not .036-.050" (.91-1.27 mm), repair as necessary. Perform VERIFICATION TEST VER-1A.

4) Inspect right front wheel speed sensor wiring harness for damage. If wiring harness is okay, go to next step. If wiring harness is damaged, repair wiring harness as necessary. Perform VERIFICATION TEST VER-1A.

5) Disconnect right front wheel speed sensor harness connector. Connector is located on right rear corner of engine compartment. Using an external ohmmeter, measure resistance of right front wheel speed sensor at harness connector terminals. If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 900-1300 ohms, replace sensor. Perform VERIFICATION TEST VER-1A.

NOTE: If excessive axle deflection occurs on extremely bumpy surfaces or during off road use, it is possible for a wheel speed sensor to set a code.

## TEST 20A

### RIGHT REAR SENSOR CIRCUIT FAILURE

1) Using DRB-II, read and record all wheel speed sensor faults. If RIGHT REAR SENSOR CIRCUIT FAILURE message is displayed, go to next step. If message is not displayed, perform TEST 21A.

2) Inspect right rear wheel speed sensor for damage. If sensor is okay, go to next step. If sensor is damaged, repair or replace as necessary. Perform VERIFICATION TEST VER-1A.

3) Turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Turn ignition on. Using DRB-II in voltmeter mode, probe Yellow wire (Yellow/Dark Blue wire on Wrangler) at CAB connector terminal No. 27. If no voltage is present, go to next step. If any voltage is present, perform TEST 20B.

4) Using DRB-II in ohmmeter mode, probe Yellow wire (Yellow/Dark Blue wire on Wrangler) at CAB connector terminal No. 27. If resistance is more than 5 ohms, go to next step. If resistance is less than 5 ohms, perform TEST 20C.

5) Using an external ohmmeter, measure resistance of right rear wheel speed sensor between Yellow wire and Yellow/Dark Blue wire at CAB connector terminals No. 27 and 45. If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 900-1300 ohms, go to next step.

6) Disconnect right rear wheel speed sensor. Using an external ohmmeter, measure resistance of right rear wheel speed sensor. If resistance is 900-1300 ohms, go to next step. If resistance is not 900-1300 ohms, replace sensor. Perform VERIFICATION TEST VER-1A.

7) Connect a jumper wire between ground and Yellow/Dark Blue

wire (Yellow wire on Wrangler) at CAB connector terminal No. 45. With DRB-II in ohmmeter mode, measure resistance of Yellow wire (Yellow/Dark Blue wire on Wrangler) at right rear wheel speed sensor harness connector. If resistance is less than 5 ohms, perform TEST 20E. If resistance is more than 5 ohms, perform TEST 20D.

## **TEST 20B**

### **RIGHT REAR SENSOR CIRCUIT FAILURE**

1) On Cherokee, repair Yellow wire for a short to battery power. Perform VERIFICATION TEST VER-1A. On Wrangler, repair Yellow/Dark Blue wire for a short to battery power. Perform VERIFICATION TEST VER-1A. On Grand Cherokee and Grand Wagoneer, disconnect and inspect Black ABS 8-pin disconnect connector. Connector is located behind left kick panel. Repair connector as necessary. With DRB-II in voltmeter mode, probe Yellow wire of ABS disconnect connector.

2) If no voltage is present, repair Yellow wire for a short to battery power between right rear wheel speed sensor and ABS disconnect connector. Perform VERIFICATION TEST VER-1A. If any voltage is present, repair Yellow wire for a short to battery power between ABS disconnect connector and CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.

## **TEST 20C**

### **RIGHT REAR SENSOR CIRCUIT FAILURE**

1) On Cherokee, repair Yellow wire for a short to ground. Perform VERIFICATION TEST VER-1A. On Wrangler, repair Yellow/Dark Blue wire for a short to ground. Perform VERIFICATION TEST VER-1A. On Grand Cherokee and Grand Wagoneer, disconnect and inspect Black ABS 8-pin disconnect connector. Connector is located behind left side kick panel. Repair connector as necessary. With DRB-II in ohmmeter mode, probe Yellow wire of ABS disconnect connector.

2) If resistance is less than 5 ohms, repair Yellow wire for a short to ground between right rear wheel speed sensor and ABS disconnect connector. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair Yellow wire for a short to ground between ABS disconnect connector and CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.

## **TEST 20D**

### **RIGHT REAR SENSOR CIRCUIT FAILURE**

1) On Cherokee, repair open Yellow/Dark Blue wire to right rear wheel speed sensor. Perform VERIFICATION TEST VER-1A. On Wrangler, repair open Yellow wire to right rear wheel speed sensor. Perform VERIFICATION TEST VER-1A. On Grand Cherokee and Grand Wagoneer, disconnect and inspect Black ABS 8-pin disconnect connector. Connector is located behind left kick panel. Repair connector as necessary. With DRB-II in ohmmeter mode, probe Yellow/Dark Blue wire of ABS disconnect connector.

2) If resistance is less than 5 ohms, repair open Yellow/Dark Blue wire between right rear wheel speed sensor and ABS disconnect connector. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open Yellow/Dark Blue wire between ABS disconnect connector and CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.



## **TEST 20E**

### **RIGHT REAR SENSOR CIRCUIT FAILURE**

1) On Wrangler, repair open Yellow/Dark Blue wire to right rear wheel speed sensor. Perform VERIFICATION TEST VER-1A. On all others, disconnect and inspect Black ABS 8-pin disconnect connector. On Cherokee, connector is located on transmission hump near firewall. On Grand Cherokee and Grand Wagoneer, connector is located behind left side kick panel. Repair connector as necessary. Connect a jumper wire between ground and Yellow wire at CAB connector terminal No. 27. With DRB-II in ohmmeter mode, probe Yellow wire of ABS disconnect connector.

2) If resistance is less than 5 ohms, repair open Yellow wire between right rear wheel speed sensor and ABS disconnect connector. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open Yellow wire between ABS disconnect connector and CAB 55-pin connector. Perform VERIFICATION TEST VER-1A.

## **TEST 21A**

### **RIGHT REAR SENSOR**

1) Inspect right rear wheel speed sensor for damage. If sensor is okay, go to next step. If sensor is damaged, repair or replace as necessary. Perform VERIFICATION TEST VER-1A.

2) Inspect right rear wheel speed sensor tone (pulse) ring for damaged teeth and excessive runout. Runout should not exceed .003" (.08 mm). Repair or replace tone ring as necessary. Perform VERIFICATION TEST VER-1A. If tone ring is okay, go to next step.

3) Using a feeler gauge, check right rear wheel sensor-to-tone ring clearance. If clearance is .036-.050" (.91-1.27 mm), go to next step. If clearance is not .036-.050" (.91-1.27 mm), repair as necessary. Perform VERIFICATION TEST VER-1A.

4) Inspect right rear wheel speed sensor wiring harness for damage. If wiring harness is okay, go to next step. If wiring harness is damaged, repair wiring harness as necessary. Perform VERIFICATION TEST VER-1A.

5) Disconnect right rear wheel speed sensor. Using an external ohmmeter, measure resistance of right rear wheel speed sensor. If resistance is 900-1300 ohms, replace CAB. Perform VERIFICATION TEST VER-1A. If resistance is not 900-1300 ohms, replace sensor. Perform VERIFICATION TEST VER-1A.

NOTE: If excessive axle deflection occurs on extremely bumpy surfaces or during off road use, it is possible for a wheel speed sensor to set a code.

## **TEST 22A**

### **ABS WARNING LIGHT ILLUMINATION PROBLEM**

1) Using DRB-II, read ABS fault codes. If any fault codes are present, perform TEST 1A. Turn ignition off. Remove ABS main relay from PDC, and inspect connector. Repair connector as necessary. Turn ignition on. If ABS warning light comes on, go to next step. If warning light does not come on, perform VERIFICATION TEST VER-1C.

NOTE: A main relay/power circuit failure fault will set with ABS

main relay removed.

2) Turn ignition off. With DRB-II in ohmmeter mode, probe Black/Tan ground wire (Black ground wire on Grand Cherokee and Grand Wagoneer) at ABS main relay socket. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Black/Tan ground wire (Black ground wire on Grand Cherokee and Grand Wagoneer). Perform VERIFICATION TEST VER-1A.

3) Ensure ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. With DRB-II in voltmeter mode, probe Gray/Yellow wire (Gray/Pink wire on Grand Cherokee and Grand Wagoneer) at ABS main relay socket. If no voltage is present, go to next step. If any voltage is present, replace ABS main relay. Perform VERIFICATION TEST VER-1A.

4) Remove ABS diode. Diode is taped to wiring harness, near CAB (near ABS 8-pin disconnect connector on Grand Cherokee and Grand Wagoneer). Connect a jumper wire between Gray/Yellow wire (Gray/Pink wire on Grand Cherokee and Grand Wagoneer) and Black/Tan wire (Black wire on Grand Cherokee and Grand Wagoneer) at ABS main relay socket terminals "B" and "E".

5) Using DRB-II in ohmmeter mode, probe Gray/Yellow wire at ABS diode connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open Gray/Yellow wire between relay splice and diode. Perform VERIFICATION TEST VER-1A.

6) Remove jumper wire used in step 4). Turn ignition on. If ABS warning light does not come on, go to next step. If ABS warning light comes on, repair Violet wire (Violet/White wire on Grand Cherokee and Grand Wagoneer or Light Green/Orange on Wrangler) for a short circuit to ground between CAB connector terminal No. 52 and ABS diode.

7) Turn ignition off. Connect a jumper wire between ground and Violet wire (Violet/White wire on Grand Cherokee and Grand Wagoneer or Light Green/Orange wire on Wrangler) at CAB connector terminal No. 52. Using DRB-II in ohmmeter mode, probe Violet wire (Violet/White wire on Grand Cherokee and Grand Wagoneer or Light Green/Orange wire on Wrangler) at ABS diode connector. If resistance is less than 5 ohms, replace ABS diode. Perform VERIFICATION TEST VER-1A. If resistance is more than 5 ohms, repair open Violet wire (Violet/White wire on Grand Cherokee and Grand Wagoneer or Light Green/Orange wire on Wrangler) between ABS warning light and diode. Perform VERIFICATION TEST VER-1A.

## **TEST 23A**

### **NO RESPONSE MESSAGE**

1) On Cherokee, remove and inspect fuse No. 7. If fuse is blown, check for possible short to ground in Light Green/Yellow wire between ignition switch and terminal No. 53 of CAB connector. If fuse is okay, go to next step. On Grand Cherokee and Grand Wagoneer, remove and inspect fuse No. 15. If fuse is blown, check for possible short to ground in Light Green/Yellow wire between ignition switch and terminal No. 53 of CAB connector. If fuse is okay, go to next step. On Wrangler, remove and inspect fuse No. 13. If fuse is blown, check for possible short to ground in Yellow/Dark Green wire between ignition switch and terminal No. 53 of CAB connector. If fuse is okay, go to next step.

2) On all models, turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary. Turn ignition on. With DRB-II in voltmeter mode, probe terminal No. 53 (Light Green/Yellow wire on Cherokee and Grand Cherokee and Grand Wagoneer or Yellow/Dark Green wire on Wrangler) of CAB connector.

3) If voltage is less than 9 volts, repair open in Light Green/Yellow wire (Cherokee and Grand Cherokee and Grand Wagoneer) or Yellow/Dark Green wire (Wrangler). Perform VERIFICATION TEST VER-1A. If voltage is more than 9 volts, turn ignition off. With DRB-II in ohmmeter mode, probe terminal No. 1 (Black wire) of CAB connector. If resistance is more than 5 ohms, repair open Black wire. Perform VERIFICATION TEST VER-1A.

4) If resistance is less than 5 ohms, probe terminal No. 19 (Black wire) of CAB connector. If resistance is more than 5 ohms, repair open Black wire. Perform VERIFICATION TEST VER-1A. If resistance is less than 5 ohms, check resistance of Violet/Brown wire (White/Violet wire on Wrangler) between terminals No. 4 of CCD bus diagnostic connector and No. 23 of CAB connector using an external ohmmeter.

5) If resistance is more than 5 ohms, repair open in Violet/Brown wire (White/Violet wire on Wrangler). Perform VERIFICATION TEST VER-1A. If resistance is less than 5 ohms, using an external ohmmeter, check resistance of White/Black wire on Cherokee, White/Gray wire on Grand Cherokee and Grand Wagoneer or Orange wire on Wrangler between terminal No. 3 of CCD bus diagnostic connector and No. 42 of CAB connector.

6) If resistance is more than 54 ohms, repair open in White/Black wire (Cherokee), White/Gray wire (Grand Cherokee and Grand Wagoneer) or Orange wire (Wrangler). Perform VERIFICATION TEST VER-1A. If resistance is less than 5 ohms, turn ignition off. Reconnect CAB 55-pin connector. Using DRB-II, try to access ABS TEVES diagnostics. If DRB-II does not display NO RESPONSE, system is functioning properly. If DRB-II displays NO RESPONSE, replace CAB. Perform VERIFICATION TEST VER-1A.

## **VERIFICATION TEST VER-1A**

### **SYSTEM VERIFICATION TEST**

1) Disconnect all previously connected jumper wires. Reconnect all previously disconnected connectors. Reinstall all previously removed relays. Replace any blown fuses. Using DRB-II, erase fault messages. Cycle ignition off and then on. Using DRB-II, monitor read faults display for 3 minutes. If DRB-II displays any faults, perform TEST 1A.

2) If DRB-II does not display any faults, using DRB-II, read brakelight switch input. Depress brake pedal. If DRB-II does not display PRESSED, perform VERIFICATION TEST VER-1B. If DRB-II displays PRESSED, using DRB-II, read "G" SWITCH input. If DRB-II does not display "G" SWITCH #1 CLOSED, "G" SWITCH #2 CLOSED, perform TEST 3A.

3) If DRB-II displays No. 1 and 2 "G" switch CLOSED, with DRB-II in ABS TEVES diagnostic mode, check ANTI-LOCK warning light. If warning light is off, perform, VERIFICATION TEST VER-1C. If warning light is flashing, depress brake pedal. Using DRB-II, actuate left front outlet valve.

4) If brake pedal "drop" was not felt when valve was actuated, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A. If brake pedal "drop" was felt when valve was actuated, release brake pedal. Depress brake pedal. Using DRB-II, actuate right front outlet valve.

5) If brake pedal "drop" was not felt when valve was actuated, replace hydraulic control unit. Perform VERIFICATION TEST VER-1A. If brake pedal "drop" was felt when valve was actuated, release brake pedal. Depress brake pedal. Using DRB-II, actuate rear outlet valve.

6) If brake pedal "drop" was not felt when valve was actuated, replace hydraulic control unit. Perform VERIFICATION TEST

VER-1A. If brake pedal "drop" was felt when valve was actuated, road test vehicle for a minimum of 5 minutes and perform several anti-lock braking stops.

7) Using DRB-II, read fault messages. If DRB-II displays any faults, perform TEST 1A. If DRB-II displays no faults, system is operating properly.

## VERIFICATION TEST VER-1B

### BRAKELIGHT SWITCH SENSOR CIRCUIT

1) Check brakelight operation. If brakelights are not operating properly, repair as necessary. Perform VERIFICATION TEST VER-1A. If brakelights are operating properly, turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary.

2) Depress brake pedal. With DRB-II in voltmeter mode, probe terminal No. 32 (White/Tan wire) of CAB connector. If voltage is less than 9 volts, repair open White/Tan wire. Perform VERIFICATION TEST VER-1A. If voltage is more than 9 volts, replace CAB. Perform VERIFICATION TEST VER-1A.

## VERIFICATION TEST VER-1C

### ANTI-LOCK WARNING LIGHT CIRCUIT

1) Set parking brake. Turn ignition on. If Red BRAKE warning light is off, repair fused ignition feed circuit to warning lights. Perform VERIFICATION TEST VER-1A. If Red BRAKE warning light is on, turn ignition off. Disconnect and inspect CAB 55-pin connector. Repair connector as necessary.

2) Turn ignition on. Connect a jumper wire between terminal No. 52 (Violet wire on Cherokee or Violet/White wire on Grand Cherokee and Grand Wagoneer or Light Green/Orange wire on Wrangler) and ground. Check ANTI-LOCK warning light. If ANTI-LOCK warning light is on, replace CAB. Perform VERIFICATION TEST VER-1A.

3) If ANTI-LOCK warning light is off, inspect ANTI-LOCK warning light bulb. Replace bulb as necessary. Perform VERIFICATION TEST VER-1A. If bulb is okay, repair open Violet wire (Cherokee) or Violet/White wire (Grand Cherokee and Grand Wagoneer) or Light Green/Orange wire (Wrangler). Perform VERIFICATION TEST VER-1A.

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Combination Valve Brakeline Fittings .....	13-18 (18-24)
Front Speed Sensor Bolt .....	11 (15)
HCU Brakeline Fittings .....	10-12 (14-16)
Master Cylinder Brakeline Fittings .....	11-13 (15-18)
Rear Speed Sensor Bolt .....	11 (15)
Wheel Lug Nuts .....	88 (119)
	INCH Lbs. (N.m)
CAB Mounting Bolts .....	75-115 (9-13)
"G" Switch Bolt .....	17-32 (2-4)
HCU Bracket Mounting Bolts .....	92-112 (10-13)

## WIRING DIAGRAMS

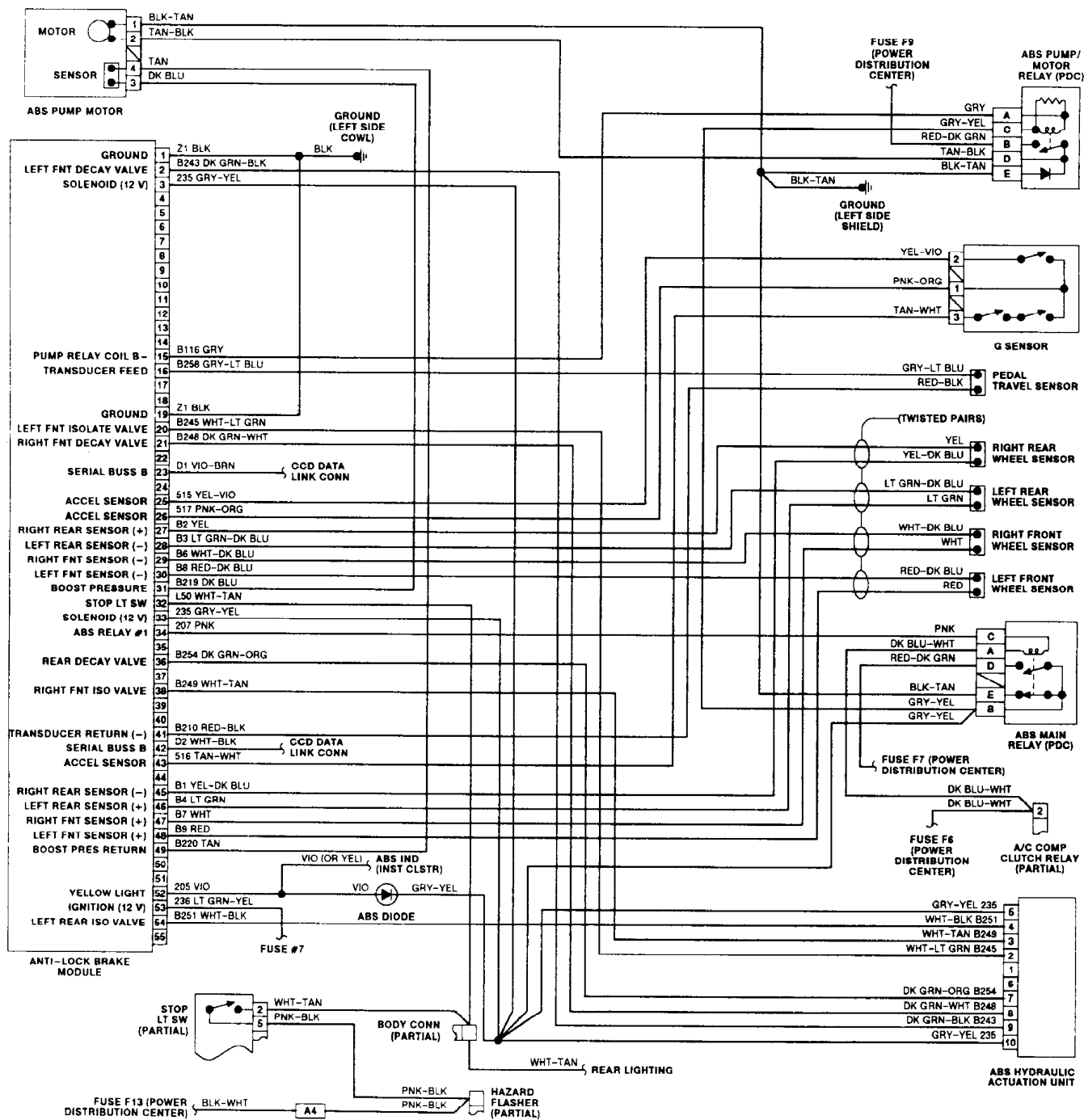
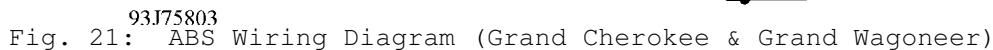
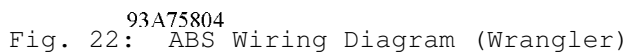


Fig. 20: ABS Wiring Diagram (Cherokee)





# ANTI-LOCK BRAKE SAFETY PRECAUTIONS

1993 Jeep Cherokee

## GENERAL INFORMATION

Anti-Lock Brake Safety Precautions

### \* PLEASE READ THIS FIRST \*

This article is intended for general information purposes only. This information may not apply to all makes and models. If vehicle is equipped with Anti-Lock Brake System (ABS), refer to appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section for description, operation, depressurizing, testing, system bleeding, trouble shooting and servicing of specific system.

WARNING: Failure to depressurize ABS could lead to physical injury.

### ANTI-LOCK BRAKE SAFETY PRECAUTIONS

WARNING: Failure to depressurize ABS could lead to physical injury.

- \* NEVER open a bleeder valve or loosen a hydraulic line while ABS is pressurized.
- \* NEVER disconnect or reconnect any electrical connectors while ignition is on. Damage to ABS control unit may result.
- \* DO NOT attempt to bleed hydraulic system without first referring to the appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section.
- \* Only use specially designed brake hoses/lines on ABS equipped vehicles.
- \* DO NOT tap on speed sensor components (sensor, sensor rings). Sensor rings must be pressed into hubs, NOT hammered into hubs. Striking these components can cause demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.
- \* DO NOT mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable. Rolling diameter must be identical for all 4 tires. Some manufacturers recommend tires of the same brand, style and type. Failure to follow this precaution may cause inaccurate wheel speed readings.
- \* DO NOT contaminate speed sensor components with grease. Only use recommended coating, when system calls for an anti-corrosion coating.
- \* When speed sensor components have been removed, ALWAYS check sensor-to-ring air gaps when applicable. These specifications can be found in each appropriate article.
- \* ONLY use recommended brake fluids. DO NOT use silicone brake fluids in an ABS equipped vehicle.
- \* When installing transmission devices (CB's, telephones, etc.) on ABS equipped vehicles, DO NOT locate the antenna near the ABS control unit (or any control unit).
- \* Disconnect all on-board computers, when using electric welding equipment.
- \* DO NOT expose the ABS control unit to prolonged periods of high heat (185 °F/85°C for 2 hours is generally considered a maximum limit).



# ANTI-THEFT SYSTEM

## 1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Anti-Theft System

Jeep; Cherokee

### DESCRIPTION & OPERATION

The Vehicle Theft Alarm (VTA) Module is a logic controlled device that monitors vehicle doors, hood, liftgate and ignition tampering. Alarm activates by sounding horn, flashing all external lights and preventing vehicle engine from running. VTA system arms during normal vehicle lock-up procedure (ignition off, all doors locked with power locks). Security light flashes for 15 seconds during arming process. Security light remains lit during arming process if no signal is received from hood switch.

When the VTA is triggered, horn sounds for 3 minutes while flashing all external lights. Headlights, park and taillights continue to flash for an additional 15 minutes after horn stops. VTA system features a tamper alert function that notifies if vehicle has been tampered with by sounding horn 3 times once a front door is unlocked. The VTA will not arm if door is locked using key or manual lock control.

**NOTE:** If vehicle battery is disconnected and reconnected, the VTA system enters a power up alarm mode. The headlights, park and taillights will flash. The engine will not run. To exit this mode, the VTA system must be disarmed using key or keyless entry transmitter.

### TROUBLE SHOOTING

**NOTE:** VTA system or VTA system self-test will be inoperative if Powertrain Control Module (PCM), has been replaced within last 20 ignition cycles.

1) System operation may be verified by entering self-test mode. To enter self-test, cycle ignition key to accessory position 3 times, leaving switch in accessory position. Once in self-test mode, headlights, park and taillights will begin flashing and horn will sound twice, verifying their operation.

**NOTE:** Vehicles equipped with VTA are also equipped with illuminated entry. Unless illuminated entry system is disabled, it is necessary to wait 30 seconds after each door opening or closure before testing can occur.

2) In self-test mode, horn will sound once after each of the following tests, indicating proper operation.

- \* Beginning with all doors closed, open and close each individual door. The horn will sound each time a door is opened or closed. Allow one second between opening and closing.
- \* Open, then close hood. Horn will sound upon opening and closing hood.
- \* Operate power door locks in both directions.
- \* Rotate key in both door lock cylinders to unlock position. Horn will sound as switch closes, and again when it opens. Allow at least one second between close and open position.

- \* Cycle ignition switch to RUN position. Horn will sound and also take VTA out of self-test mode.
- \* Activate remote keyless entry in both lock and unlock directions.

3) Horn not sounding after any of the above operations indicates a switch failure, lack of input signal to VTA module or internal failure of module.

4) Check for continuity at switch. Check for open or shorted wire between switch and alarm module. See appropriate wiring diagram in the WIRING DIAGRAMS article in the ENGINE PERFORMANCE section. Check if PCM has been replaced. When PCM is replaced, it is necessary to cycle ignition switch through 20 engine starts to initialize system.

5) Whenever a VTA system malfunction occurs, verify wire harness is properly connected to all connectors before starting normal diagnosis and repair procedures. If security lamp comes on and remains on after ignition is turned on, CCD bus communication signal with PCM has been lost.

## CONNECTOR IDENTIFICATION

### CONNECTOR IDENTIFICATION DIRECTORY TABLE

Connector	Go to Figure
Front Door Key Cylinder Switch .....	See Fig. 1.
Liftgate Key Cylinder Switch .....	See Fig. 2.
Mechanical Instrument Cluster .....	See Fig. 3.
Powertrain Control Module .....	See Fig. 4.
Remote Keyless Entry Module .....	See Fig. 5.
Vehicle Fuse Block .....	See Fig. 6.
Vehicle Relay Center .....	See Fig. 7.
Vehicle Theft Alarm Module .....	See Fig. 8.

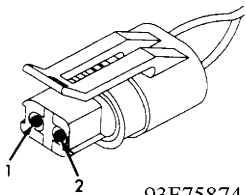


Fig. 1: Identifying Front Door Key Cylinder Switch Connector  
Courtesy of Chrysler Corp.

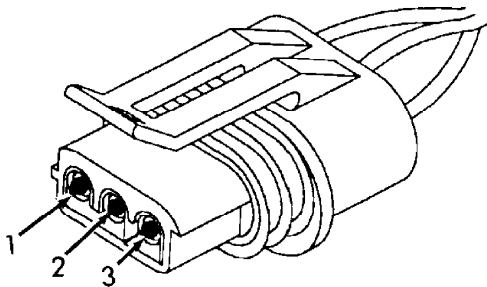
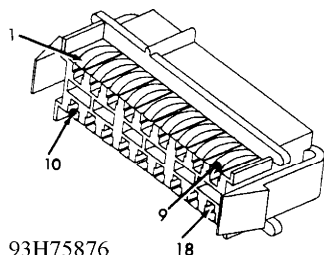
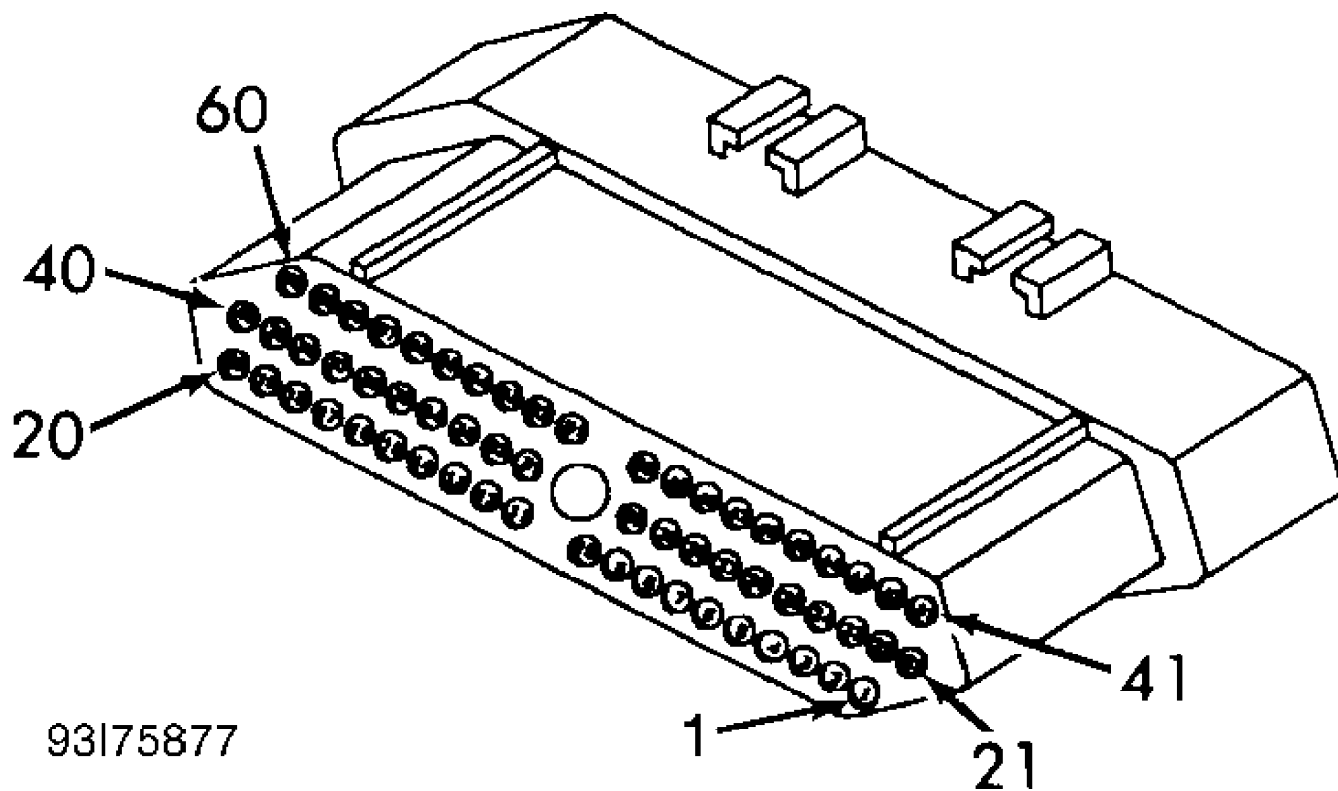


Fig. 2: Identifying Liftgate Key Cylinder Switch Connector  
Courtesy of Chrysler Corp.



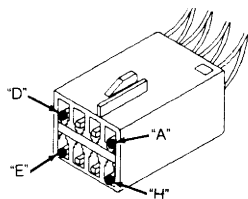
93H75876

Fig. 3: Identifying Mechanical Instrument Cluster Connector  
Courtesy of Chrysler Corp.



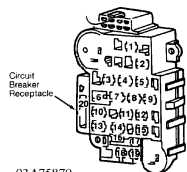
93J75877

Fig. 4: Identifying Powertrain Control Module Connector  
Courtesy of Chrysler Corp.



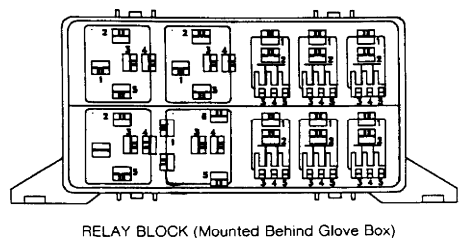
93J75878

Fig. 5: Identifying Remote Keyless Entry Module Connector  
Courtesy of Chrysler Corp.



93A75879

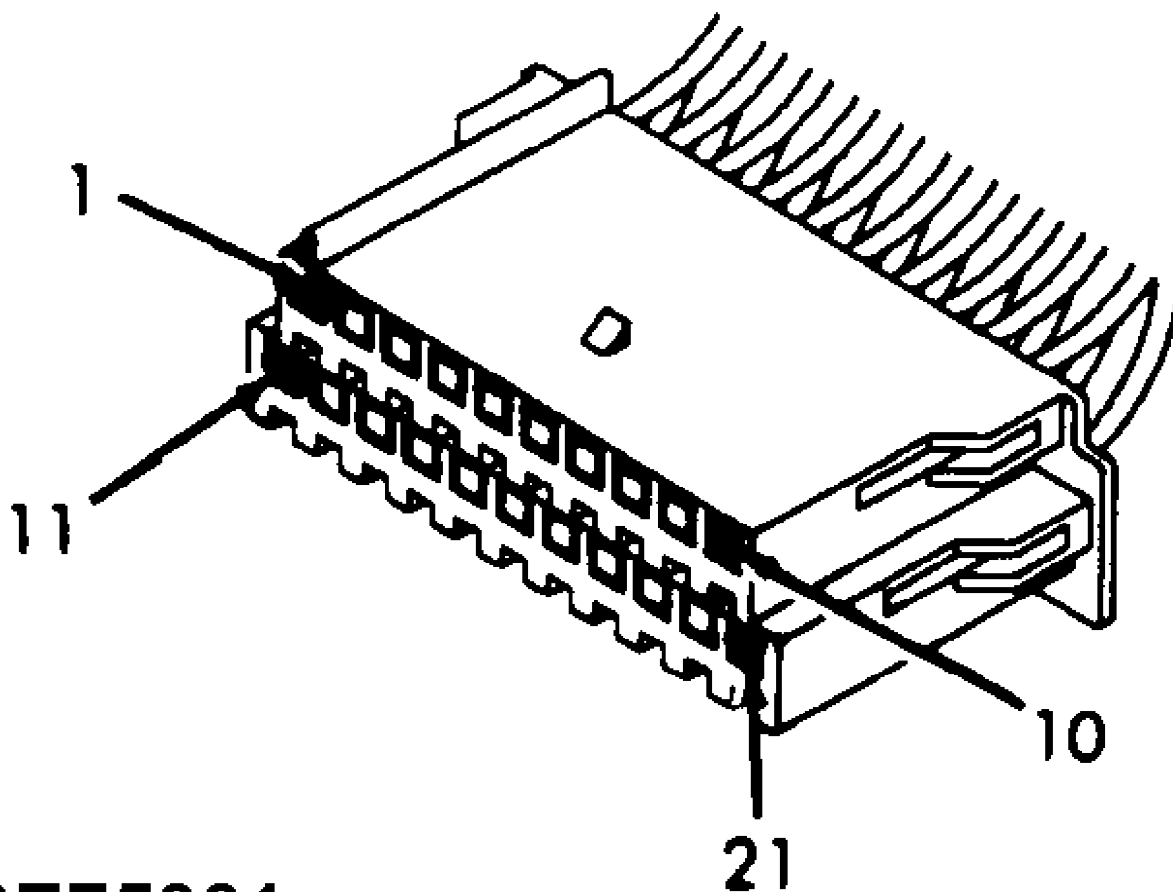
Fig. 6: Identifying Vehicle Fuse Block  
Courtesy of Chrysler Corp.



RELAY BLOCK (Mounted Behind Glove Box)

93D75880

Fig. 7: Identifying Vehicle Relay Center  
Courtesy of Chrysler Corp.



**93E75881**

Fig. 8: Identifying Vehicle Theft Alarm Module Connector  
Courtesy of Chrysler Corp.

## TESTING

**NOTE:** In the following tests, illustrations are courtesy of Chrysler Corp. For connector terminal identification, see the CONNECTOR IDENTIFICATION table. For wiring diagrams, the appropriate chassis wiring diagram in WIRING DIAGRAMS article in ENGINE PERFORMANCE section.

**CAUTION:** Always turn ignition switch to OFF position prior to

disconnecting or connecting any module connector. Once connector is disconnected, ignition can be turned on.

**NOTE:** There are no diagnostic or trouble codes for Vehicle Theft Alarm system. Only symptom diagnosis and repair are provided by the manufacturer.

## USING DRB-II

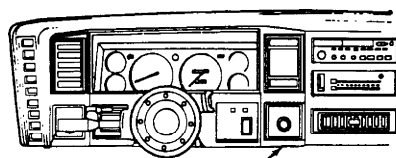
**NOTE:** Although other scan testers are available, manufacturer recommends using DRB-II (Diagnostic Readout Box II) to diagnose system.

**WARNING:** DO NOT probe connector with an ohmmeter unless specifically instructed in testing procedure. There is a possibility of air bag deployment.

Ensure DRB-II is connected to CCD data link connector located in behind dash on right side of steering column. See Fig. 9. Ensure correct cartridge is installed in DRB-II for vehicle and system being diagnosed. Menu selections will vary depending on vehicle and system being diagnosed. Follow DRB-II screen prompts to actuate, adjust, monitor, reset, test and diagnose system as necessary.

DRB-II is grounded through CCD data link connector, only one volt-ohmmeter test lead is required when using volt-ohmmeter option. DRB-II volt-ohmmeter should only be used when self-diagnostic tests require the use of this option.

If DRB-II has a blank screen or displays RAM TEST FAILURE, CARTRIDGE ERROR, KEY PAD TEST FAILURE, LOW BATTERY or HIGH BATTERY, this indicates a DRB-II failure. To diagnose and correct these conditions, see BODY CONTROL COMPUTER - VEHICLE COMMUNICATIONS article in ENGINE PERFORMANCE.



CCD DATA LINK CONNECTOR  
(Mounted Behind Dash, Right Side Of Column)

93C75871

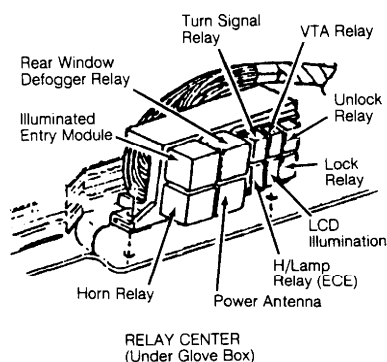
Fig. 9: Identifying Location Of CCD Data Link Connector  
Courtesy of Chrysler Corp.

## TEST 1A - TESTING SYSTEM FUNCTION

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Connect DRB-II to data link connector. See Fig. 9. If DRB-II displays SELECT SYSTEM, select VTA MODULE. If DRB-II is blank or displays anything other than SELECT SYSTEM, see BODY CONTROL COMPUTER - VEHICLE COMMUNICATIONS article in the ENGINE PERFORMANCE section.

2) If after selecting VTA MODULE the DRB-II displays NO RESPONSE, go to TEST 2A. If after selecting VTA MODULE the DRB-II screen does not display NO RESPONSE, disconnect the illuminated entry module. See Fig. 10. Ensure all doors, hood and liftgate are fully closed.



93F75882

Fig. 10: Identifying Relay Center Location

3) If security light flashes constantly, go to TEST 3A. If security light does not flash, switch VTA status to diagnostic using DRB-II. If DRB-II does not display TURN IGNITION KEY TO ACC. POSITION, go to TEST 4A. If DRB-II displays TURN IGNITION KEY TO ACC. POSITION, turn ignition switch to ACC. position.

4) If DRB-II displays NO RESPONSE after turning key to ACC. position, go to TEST 5A. If after turning key to ACC. position horn does not sound, go to TEST 6A. If horn does sound, check if security light is flashing. If security light is flashing, check if park and headlights are flashing.

5) Go to TEST 7A if security light is not flashing. Go to TEST 8A if exterior lights are not flashing. If exterior lights are flashing, turn ignition off and open left front door. Close door. If horn does not sound, go to TEST 9A.

6) If horn does sound, open right front door. Close door. If horn does not sound, go to TEST 9A. If horn does sound, open right rear door. Close door. If horn does not sound, go to TEST 9A. If horn does sound, open left rear door. Close door. If horn does not sound, go to TEST 9A.

7) If horn does sound, open hood. Close hood. If horn does not sound, go to TEST 10A. If horn does sound, open liftgate. Close liftgate. If horn does not sound, go to TEST 11A. If horn does sound, push power door lock switch to LOCK position.

8) If horn does not sound, go to TEST 12A. If horn does sound, push power door lock switch to UNLOCK position. If horn does not sound, go to TEST 13A. If horn does sound, rotate key in left front door lock to UNLOCK position. If horn does not sound, proceed to TEST 14A.

9) If horn does sound, rotate key in right front door lock to UNLOCK position. If horn does not sound, go to TEST 15A. If horn does sound, rotate key in liftgate to UNLOCK position. If horn does not sound, go to TEST 16A.

10) If horn does sound, turn ignition on. If horn does not sound, go to TEST 4A. If horn does sound, read vehicle theft alarm status with DRB-II. If the DRB-II does not display CURRENT MODE DISARMED, go to TEST 1B. If DRB-II does display CURRENT MODE DISARMED, DRB-II screen should display ENGINE CONTROLLER: 1) NO RESPONSE, 2) NO RESPONSE ?. If message is displayed, go to TEST 17A.

11) If DRB-II displays the message, ENGINE CONTROLLER: 1) OK TO RUN ARM VTA, 2) OK TO RUN ENGINE ?, go to TEST 18A if malfunction is caused by keyless entry, arm or disarm. If message is not displayed, replace Powertrain Control Module (PCM).

12) If keyless entry is working properly, determine if engine controller has been replaced. If engine controller has not been replaced, system is functioning properly. Engine has to cycle through 20 ignition starts before VTA becomes operational (assembly plant alarm override feature).

## TEST 1B - TESTING SYSTEM FUNCTION

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

Ensure ignition is off. Turn left door lock to UNLOCK position and turn ignition on. Using DRB-II, read VTA status. If DRB-II displays CURRENT MODE DISARMED, system is functioning properly. Perform TEST VER-1. If screen does not display CURRENT MODE DISARMED, replace VTA module. Perform TEST VER-1.

## TEST 2A - REPAIRING NO RESPONSE

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Ensure ignition switch is off. Disconnect VTA module. See Fig. 11. Using DRB-II in ohmmeter mode, test system ground circuit for resistance at VTA module connector.

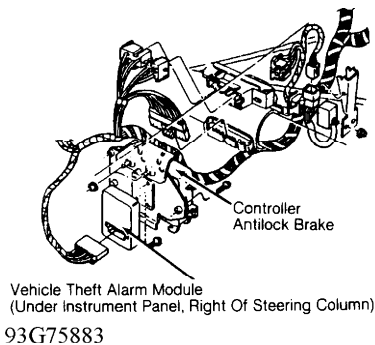


Fig. 11: Identifying Vehicle Theft Alarm Location

2) Check resistance at terminal No. 21 (Black wire). If resistance is more than 0-15 ohms, repair open circuit. Perform TEST VER-1. If resistance is less than 0-15 ohms, turn ignition on.

3) Using DRB-II in voltmeter mode, check voltage at terminal No. 8 (Dark Blue/White wire) of VTA module connector. If voltage is less than 10 volts, go to TEST 2B. If voltage is more than 10 volts, check ignition voltage at terminal No. 12 (Dark Blue wire). If voltage is less than 10 volts, go to TEST 2C. If voltage is more than 10 volts, disconnect DRB-II.

4) Using external ohmmeter, check resistance between pin No. 4 (Violet/Brown wire) of CCD data link connector and terminal No. 9 (Violet/Brown wire) of VTA module connector. If resistance is more than 5 ohms, repair open circuit. Perform TEST VER-1. If resistance is less than 5 ohms, check resistance between pin No. 3 (White/Black wire) of CCD data link connector and terminal No. 10 (White/Black wire) of VTA module connector. If resistance is more than 5 ohms, repair open circuit. Perform TEST VER-1. If resistance is less than 5 ohms, replace VTA module. Perform TEST VER-1.

## TEST 2B - REPAIRING NO RESPONSE

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate

wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Remove fuse No. 4 from fuse block and inspect. If fuse is open (NG), check resistance between terminal No. 8 (Dark Blue/ White wire) of VTA module connector using DRB-II. If resistance is less than 5 ohms, repair shorted wire. If resistance is more than 5 ohms, replace No. 4 fuse. Perform TEST VER-1.

2) If No. 4 fuse is good when removed, check voltage feed circuit with DRB-II. Connect DRB-II to voltage feed terminal of No. 4 fuse (right side of connector) receptacle. If voltage is less than 10 volts, repair open circuit between fuse receptacle and terminal No. 8 (Dark Blue/White wire) of VTA module connector. Perform TEST VER-1. If voltage is more than 10 volts, repair open circuit between terminal No. 12 (Dark Blue wire) of VTA module connector and terminal No. 4 (Violet/Brown wire) of wiper circuit breaker receptacle of fuse block. Perform TEST VER-1.

## TEST 2C - REPAIRING NO RESPONSE

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Remove wiper circuit breaker from fuse block. Using DRB-II, check voltage at ignition voltage feed, terminal No. 4 (Violet/Brown wire) of circuit breaker receptacle. If voltage is less than 10 volts, repair open ignition voltage feed circuit (Violet/Brown wire). Perform TEST VER-1.

2) If voltage is more than 10 volts, check circuit resistance with DRB-II. Check resistance at terminal No. 12 (Dark Blue wire) of VTA module connector. If resistance is less than 5 ohms, repair ignition voltage feed circuit (Dark Blue wire) for short to ground. Replace wiper circuit breaker. Perform TEST VER-1.

3) If resistance is more than 5 ohms, check resistance between terminal No. 12 (Dark Blue) of VTA module connector and terminal No. 2 of circuit breaker receptacle of fuse block. If resistance is less than 5 ohms, replace circuit breaker. If resistance is more than 5 ohms, repair open ignition feed circuit (Dark Blue wire). Perform TEST VER-1.

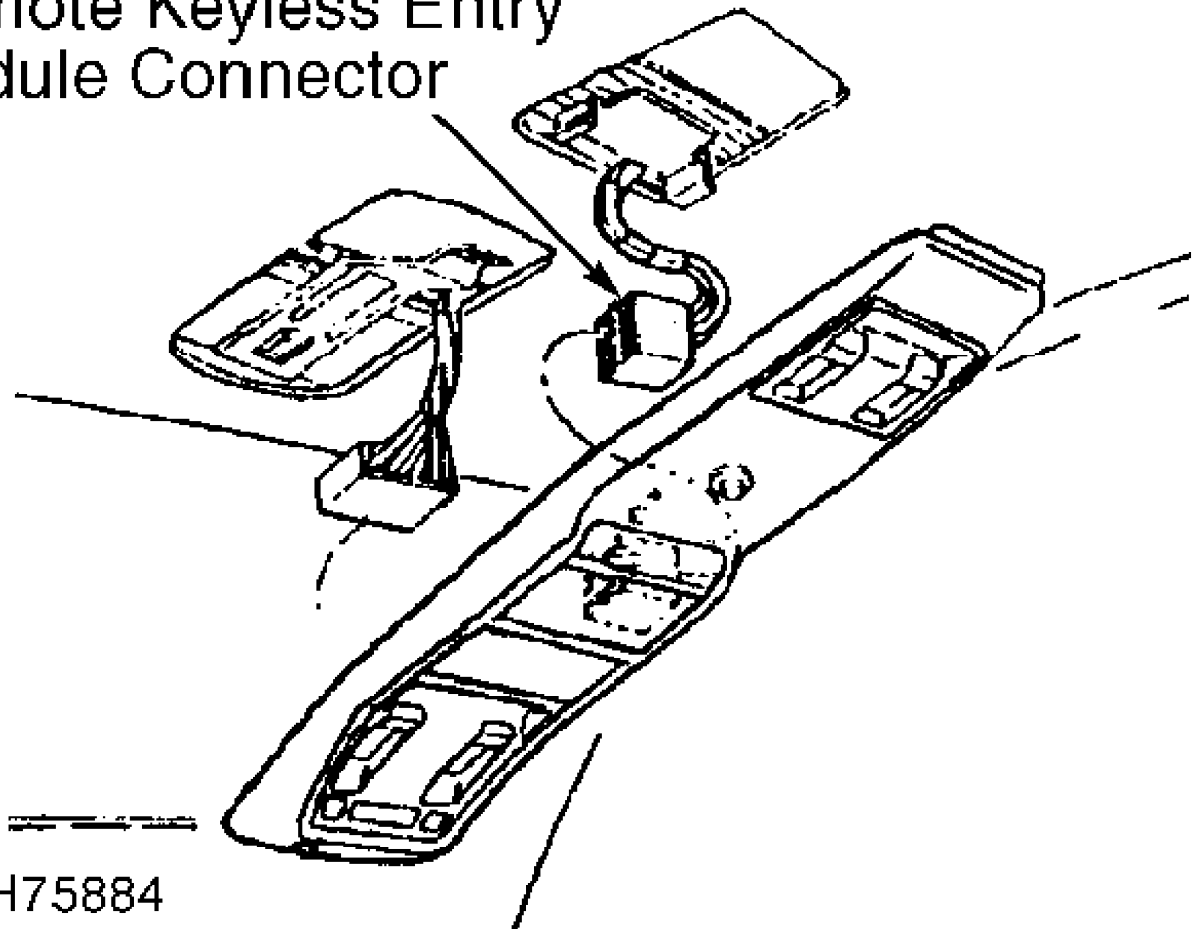
## TEST 3A - REPAIRING SECURITY LIGHT FLASHING CONSTANTLY

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect VTA module. See Fig. 11 in TEST 2A. Using DRB-II, check voltage at arm sense terminal No. 6 (Pink/Orange wire) of VTA module connector. If voltage is less than one volt, replace VTA module. Perform TEST VER-1. If voltage is more than one volt, disconnect remote keyless entry module. See Fig. 12.



# Remote Keyless Entry Module Connector



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Fig. 12: Identifying Remote Keyless Entry Module Location

2) Using DRB-II, check voltage at arm sense circuit terminal No. 6 (Pink/Orange wire). If voltage is more than one volt, repair shorted arm sense (Pink/Orange wire). Perform TEST VER-1. If voltage is less than one volt, replace remote keyless entry module. Perform TEST VER-1.

## TEST 4A - REPAIRING IGNITION INPUT CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Ensure ignition is turned off. Disconnect VTA module. Turn ignition on. Using DRB-II, check voltage at terminal No. 8 (Dark Blue/White wire) of VTA module connector. If voltage is more than 10 volts, replace VTA module. Perform TEST VER-1.

2) If voltage is less than 10 volts, remove No. 4 fuse and inspect. If fuse is open (NG), check resistance at terminal No. 8 (Dark Blue/White wire) of VTA module connector with DRB-II. If resistance is less than 5 ohms, repair ignition voltage feed circuit terminal No. 8 (Dark Blue/White wire) shorted to ground. Perform TEST VER-1.

3) If resistance is more than 5 ohms, replace fuse. If fuse No. 4 is not open (good), check voltage feed circuit at fuse No. 4

(right side of receptacle) with DRB-II. If voltage is less than 10 volts, repair open circuit between fuse receptacle and terminal No. 8 (Dark Blue/White wire) of VTA module connector. Perform TEST VER-1. If voltage is more than 10 volts, repair open circuit between pin No. 12 (Dark Blue wire) of VTA module connector and terminal No. 4 (Violet/Brown wire) of wiper circuit breaker of fuse block. Perform TEST VER-1.

## TEST 5A - REPAIRING IGNITION INPUT CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Ensure ignition is off. Disconnect VTA module. Turn ignition on. Using DRB-II, check voltage at terminal No. 12 (Dark Blue wire) of VTA module connector. If voltage is more than 10 volts, replace VTA module. Perform TEST VER-1. If voltage is less than 10 volts, remove wiper circuit breaker.

2) Using DRB-II, check voltage at terminal No. 4 (Light Green/Black wire) of circuit breaker receptacle. If voltage is less than 10 volts, repair open voltage feed circuit (Light Green/Black wire). If voltage is more than 10 volts, check resistance at terminal No. 2 (Light Green/Black wire) of wiper circuit breaker receptacle and terminal No. 12 (Dark Blue wire) of VTA module connector.

3) If resistance is less than 5 ohms, repair shorted circuit. Perform TEST VER-1. Replace circuit breaker. If resistance is more than 5 ohms, repair open voltage feed circuit. Perform TEST VER-1.

## TEST 6A - REPAIRING HORN CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Push horn button on steering wheel. If horn sounds, disconnect VTA module. Using DRB-II, check voltage at terminal No. 5 (Black/Red wire) of VTA module connector. If voltage is less than 10 volts, repair open horn relay control circuit (Black/Red wire).

2) If voltage is more than 10 volts, check voltage on fused battery feed circuit, terminal No. 2 (Gray/Pink wire) of VTA module connector. If voltage is less than 10 volts, repair open fused battery voltage feed wire. If voltage is more than 10 volts, replace VTA module. Perform TEST VER-1.

3) If horn did not sound when pushing steering wheel button, disconnect VTA module. Connect jumper wire between horn relay control wire (terminal No. 5 of VTA module connector) and ground. If horn sounds, replace VTA module. See the appropriate STEERING COLUMN SWITCHES article in the ACCESSORIES/SAFETY EQUIP section for horn button/wiring repair.

4) If horn does not sound, remove horn relay. See Fig. 10 in TEST 1A. Using DRB-II, check fused battery feed voltage at terminal No. 1 of horn relay receptacle. If voltage is less than 10 volts, go to TEST 6B.

5) If voltage is more than 10 volts, check voltage at fused battery feed terminal No. 5 (Gray/Pink wire) of horn relay receptacle. If voltage is less than 10 volts, repair open fused battery feed circuit (Gray/Pink wire). Perform TEST VER-1.

6) If voltage is more than 10 volts, check resistance between terminal No. 2 (Black/Red wire) of horn relay receptacle and terminal No. 5 (Black/Red wire) of VTA module connector with external ohmmeter.

If resistance is more than 5 ohms, repair open horn control circuit (Black/Red wire). Perform TEST VER-1.

7) If resistance is less than 5 ohms, connect a jumper wire between terminals No. 1 (Pink/Light Green wire) and No. 4 (Dark Green/Red wire) of horn relay receptacle. If horn sounds, replace horn relay. Perform TEST VER-1. If horn does not sound, repair open horn feed circuit (Dark Green/Red wire). Perform TEST VER-1.

## TEST 6B - REPAIRING HORN CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Remove and inspect fuse No. 11. If fuse is open (NG), check resistance of fused battery feed at terminal No. 2 (Gray/Pink wire) of VTA module connector with DRB-II. If resistance is less than 5 ohms, repair fused battery feed circuit (Gray/Pink wire) for short to vehicle ground. Replace fuse. Perform TEST VER-1. If resistance is more than 5 ohms, replace fuse. Perform TEST VER-1.

2) If fuse No. 11 is not open (good), check voltage on battery feed side of fuse receptacle (Red/Yellow wire on left side of receptacle) using DRB-II. If voltage is more than 10 volts, repair open fused battery feed wire. Perform TEST VER-1. If voltage is less than 10 volts, repair open battery feed wire. Perform TEST VER-1. Both wires are Gray/Pink.

## TEST 7A - REPAIRING SECURITY INDICATOR LIGHT CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition on. If security indicator light is constantly on, go to TEST 7B. If security light is not on constantly, disconnect VTA module. Connect jumper wire between security light control circuit terminal No. 17 (Black/Orange wire) of VTA module connector and vehicle ground.

2) If security light illuminates, replace VTA module. If security light does not illuminate, disconnect Mechanical Instrument Cluster (MIC) Natural color connector. Remove instrument cluster. See appropriate INSTRUMENT PANELS article in the ACCESSORIES/SAFETY EQUIP section. Visually inspect condition of instrument cluster circuit board. Replace circuit board if damaged. Perform TEST VER-1.

3) If circuit board is okay, inspect security indicator light bulb. Replace bulb if open (NG). Perform TEST VER-1. If security indicator light bulb is good, check fused battery feed voltage at terminal No. 10 (Pink wire) of MIC Natural color connector.

4) If voltage is less than 10 volts, repair open fused battery feed circuit (Pink wire). Perform TEST VER-1. If voltage is more than 10 volts, repair open security indicator light control (Black/Orange wire). Perform TEST VER-1.

## TEST 7B - REPAIRING SECURITY INDICATOR LIGHT CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

Disconnect VTA module. See Fig. 11 in TEST 2A. If security

indicator light illuminates, repair security indicator light control (Black/Orange wire) for short to ground. Perform TEST VER-1. If security indicator light does not illuminate, replace VTA module. Perform TEST VER-1.

## TEST 8A - REPAIRING PARKING LIGHT CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) If headlights do not flash, go to TEST 8B. If headlights do flash, turn parking lights on. If parking lights do not illuminate, see appropriate STEERING COLUMN SWITCHES article in the ACCESSORIES/SAFETY EQUIP section for repair. If parking lights do illuminate, disconnect VTA module. See Fig. 11 in TEST 2A.

2) Using DRB-II, check voltage of park/taillight control circuit at terminal No. 4 (Dark Blue/Red wire) of VTA module connector. If voltage is less than 10 volts, repair open park/taillight control (Dark Blue/Red wire).

3) If voltage is more than 10 volts, check voltage of fused battery feed circuit at terminal No. 2 (Gray/Pink wire) of VTA module connector using DRB-II. If voltage is less than 10 volts, go to TEST 8D. If voltage is more than 10 volts, check voltage of fused battery feed circuit at terminal No. 11 (Pink/Light Green wire) of VTA module connector using DRB-II. If voltage is less than 10 volts, go to TEST 8C. If voltage is more than 10 volts, replace VTA module. Perform TEST VER-1.

## TEST 8B - REPAIRING HEADLIGHT CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Switch headlights on to high beam. If high beam headlights fail to illuminate, see appropriate STEERING COLUMN SWITCHES article in ACCESSORIES/SAFETY EQUIP section for repair. If high beam headlights illuminate, disconnect VTA relay. See Fig. 10 in TEST 1A. DO NOT turn off high beam headlights.

2) Check VTA relay output voltage at terminal No. 2 (Red/Orange wire) of VTA relay receptacle using DRB-II. If voltage is less than 10 volts, repair open VTA relay output circuit (Red/Orange wire). Perform TEST VER-1. If voltage is more than 10 volts, check fused battery feed voltage at terminal No. 1 (Pink/Light Green wire) of VTA relay receptacle using DRB-II.

3) If voltage is less than 10 volts, go to TEST 8C. If voltage is more than 10 volts, check resistance of relay ground (Black wire) at terminal No. 3 of VTA relay receptacle using DRB-II. If resistance is more than 20 ohms, repair open VTA relay ground. Perform TEST VER-1.

4) If resistance is less than 20 ohms, disconnect VTA module. See Fig. 11 in TEST 2A. Using DRB-II, check fused battery feed voltage at terminal No. 11 (Pink/Light Green wire) of VTA module connector. If voltage is less than 10 volts, repair open fused battery feed circuit (Pink/Light Green wire). Perform TEST VER-1.

5) If voltage is more than 10 volts, check fused battery feed circuit voltage at terminal No. 2 (Gray/Pink wire) of VTA module connector using DRB-II. If voltage is less than 10 volts, go to TEST 8D. If voltage is more than 10 volts, check VTA relay control circuit resistance at terminal No. 18 (Tan/Pink wire) of VTA module connector

using DRB-II.

6) If resistance is less than 5 ohms, repair VTA relay control circuit wire for short to vehicle ground. If resistance is more than 5 ohms, check resistance between terminal No. 5 (Tan/Pink wire) of VTA relay control receptacle and terminal No. 18 (Tan/Pink wire) of VTA module connector using external ohmmeter.

7) If resistance is more than 5 ohms, repair open VTA relay control circuit (Tan/Pink wire). Perform TEST VER-1. If resistance is less than 5 ohms, reconnect VTA relay. Connect jumper wire between terminal No. 11 (Pink/Light Green wire) and terminal No. 18 (Tan/Pink wire) of VTA module connector. If headlights illuminate, replace VTA module. Perform TEST VER-1. If headlight do not illuminate, replace VTA relay. Perform TEST VER-1.

## TEST 8C - REPAIRING BATTERY SUPPLY INPUT CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Remove and inspect fuse No. 3. If fuse is open (NG), check fused battery feed circuit resistance at terminal No. 2 (Pink/Light Green) of VTA module connector using DRB-II. If resistance is less than 5 ohms, repair fused battery feed wire for short to ground. Replace fuse. If resistance is more than 5 ohms, replace fuse. Perform TEST VER-1.

2) If No. 3 fuse is good, check fuse No. 3 receptacle (left side of receptacle) feed voltage using DRB-II. If voltage is less than 10 volts, repair open battery feed wire. Perform TEST VER-1. If voltage is more than 10 volts, repair open fused battery feed wire. Perform TEST VER-1.

## TEST 8D - REPAIRING BATTERY SUPPLY INPUT CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Remove and inspect fuse No. 11. If fuse is open (NG), check fused battery feed circuit resistance at terminal No. 11 (Gray/Pink wire) of VTA module connector using DRB-II. If resistance is less than 5 ohms, repair fused battery feed wire for short to ground. Perform TEST VER-1. Replace fuse. If resistance is more than 5 ohms, replace fuse. Perform TEST VER-1.

2) If No. 11 fuse is good, check fuse No. 11 receptacle (left side of receptacle) feed voltage using DRB-II. If voltage is less than 10 volts, repair open battery feed wire. Perform TEST VER-1. If voltage is more than 10 volts, repair open fused battery feed wire. Perform TEST VER-1.

## TEST 9A - REPAIRING DOOR JAMB SENSE CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

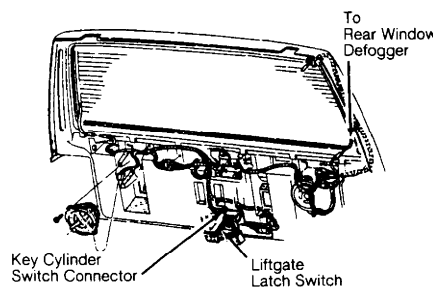
1) Ensure all doors, hood and liftgate are closed. Ensure all courtesy, dome and cargo lights function properly. Repair any interior lights that are not functioning.

2) Using DRB-II, read DOOR AJAR status. If status screen does

not display closed (CLSD), go to TEST 9B. If DRB-II displays closed (CLSD) status, disconnect left front door jamb switch. If status screen does not display closed (CLSD), replace door jamb switch. Perform TEST VER-1.

3) If DRB-II displays closed (CLSD) status, disconnect left rear door jamb switch. If status screen does not display closed (CLSD), replace door jamb switch. Perform TEST VER-1. If DRB-II displays closed (CLSD) status, disconnect right front door jamb switch. If status screen does not display closed (CLSD), replace door jamb switch. Perform TEST VER-1.

4) If DRB-II displays closed (CLSD) status, disconnect right rear door jamb switch. If status screen does not display closed (CLSD), replace door jamb switch. Perform TEST VER-1. If DRB-II displays closed (CLSD) status, disconnect liftgate latch sense switch. See Fig. 13. If status screen does not display closed (CLSD), replace liftgate latch sense switch. Perform TEST VER-1.



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Fig. 13: Identifying Liftgate Latch Switch Location

5) If DRB-II displays closed (CLSD) status, disconnect VTA module. See Fig. 11 in TEST 2A. Using DRB-II, check door jamb sense circuit voltage at terminal No. 3 (Yellow wire) of VTA module. If voltage is less than 10 volts, repair open door jamb sense wire. Perform TEST VER-1.

6) If voltage is more than 10 volts, check resistance of liftgate latch sense (Violet/Yellow wire) at terminal No. 1 of VTA module connector using DRB-II. If resistance is less than 5 ohms, repair liftgate latch sense wire for short to ground. Perform TEST VER-1.

7) If resistance is more than 5 ohms, determine if any previous repairs were done. Replace VTA module if no repairs were done. Perform TEST VER-1. If repairs were done, perform TEST VER-1.

## TEST 9B - REPAIRING DOOR JAMB SENSE CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

Disconnect VTA module. See Fig. 11 in TEST 2A. Using DRB-II, check door jamb sense circuit voltage at terminal No. 3 (Yellow wire) of VTA module connector. If voltage is less than 10 volts, repair open door jamb sense wire. Perform TEST VER-1. If voltage is more than 10 volts, replace VTA module. Perform TEST VER-1. See Fig. 11 in TEST 2A.

## TEST 10A - REPAIRING HOOD AJAR SENSE CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram

in the WIRING DIAGRAMS section.

1) Ensure hood is closed and aligned properly. Using DRB-II, read HOOD AJAR status. If DRB-II does not display closed (CLSD) status, go to TEST 10B. If displays closed (CLSD) status, disconnect hood ajar switch. Using DRB-II, check resistance of hood ajar sense circuit at terminal No. 20 (Brown/Tan wire) of VTA module connector.

2) If resistance is less than 5 ohms, repair hood ajar sense wire for short to ground. Perform TEST VER-1. If resistance is more than 5 ohms, replace VTA module. Perform TEST VER-1.

## TEST 10B - REPAIRING HOOD AJAR CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect hood ajar switch. Connect jumper wire between hood ajar sense wire (at switch) and vehicle ground. Using DRB-II, read HOOD AJAR switch status. If screen displays closed (CLSD), replace switch. If DRB-II screen does not display closed (CLSD), connect jumper wire between hood ajar sense wire (at VTA module connector) and vehicle ground.

2) Ensure connector is connected to VTA module. Using DRB-II, read HOOD AJAR switch status. If status screen displays closed, repair open hood ajar sense wire. Perform TEST VER-1. If screen does not display closed, replace VTA module. Perform TEST VER-1.

## TEST 11A - REPAIRING LIFTGATE LATCH SENSE CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Ensure all doors, hood and liftgate are properly closed and aligned. VTA system should still be diagnostic mode.

2) Using DRB-II, read DOOR AJAR status screen. If screen displays closed (CLSD), go to TEST 9A. If status screen does not display closed (CLSD), open liftgate and turn on cargo light. If horn sounds, system is functioning properly. Cargo light switch must be in ON position to fully arm VTA system. Return back to TEST 1A.

3) If horn does not sound, disconnect liftgate latch switch connectors. Using DRB-II, check resistance of latch switch ground wire. If resistance is more than 5 ohms, repair open latch switch ground wire. Perform TEST VER-1. If resistance is less than 5 ohms, connect jumper wire between liftgate latch switch connectors.

4) Using DRB-II, read DOOR AJAR status. If status screen displays closed (CLSD), replace liftgate latch switch. Perform TEST VER-1. If status screen does not display closed (CLSD), connect jumper wire between ground (Black wire) and latch switch sense (Violet/Yellow wire).

5) Using DRB-II, read DOOR AJAR status. If screen does not display closed (CLSD), replace VTA module. If status screen does display closed (CLSD), disconnect VTA module. Using DRB-II, check liftgate latch sense circuit voltage at terminal No. 1 (Violet/Yellow wire) of VTA module connector. If voltage is more than 10 volts, replace cargo light switch. Perform TEST VER-1. If voltage is less than 10 volts, repair open liftgate latch sense wire. Perform TEST VER-1.

## TEST 12A - REPAIRING DOOR LOCK SENSE CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Determine that power doors locks are functioning properly.  
Repair door locks that are not functioning properly.

2) Disconnect VTA module. See Fig. 11 in TEST 2A. Using DRB-II, check lock switch sense (Orange/Violet wire) voltage at terminal No. 15 of VTA module connector. While measuring voltage, push power lock switch to LOCK position.

3) If voltage is more than 10 volts, replace VTA module. Perform TEST VER-1. If voltage is less than 10 volts, repair open lock switch sense circuit (Orange/Violet wire). Perform TEST VER-1.

### TEST 13A - REPAIRING DOOR UNLOCK SENSE CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Determine that power doors locks are functioning properly.  
Repair door locks that are not functioning properly.

2) Disconnect VTA module. See Fig. 11 in TEST 2A. Using DRB-II, check unlock switch sense voltage at terminal No. 16 (Pink/Violet wire) of VTA module connector. While measuring voltage, push power lock switch to UNLOCK position.

3) If voltage is more than 10 volts, replace VTA module. Perform TEST VER-1. If voltage is less than 10 volts, repair open unlock switch sense circuit (Pink/Violet wire). Perform TEST VER-1.

### TEST 14A - REPAIRING LEFT DOOR KEY CYLINDER CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If DRB-II status screen displays CIRCUIT CLOSED (CLSD), go to TEST 15B. If screen does not display CIRCUIT CLOSED (CLSD), disconnect left front door switch connector.

2) Connect jumper wire across both terminals of connector. Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If status screen displays CIRCUIT CLOSED (CLSD), replace left front door key cylinder switch. Perform TEST VER-1.

3) If DRB-II screen does not display CIRCUIT CLOSED (CLSD), connect jumper wire between right terminal No. 2 (Light Green/Orange wire) of left front door switch connector and vehicle ground. Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status.

4) If screen displays CIRCUIT CLOSED (CLSD), repair switch ground wire for open to ground. Perform TEST VER-1. If DRB-II screen does not display CIRCUIT CLOSED (CLSD), connect jumper wire between terminal No. 7 (Light Green/Orange wire) of VTA module connector and vehicle ground. DO NOT disconnect VTA module connector.

5) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If screen displays CIRCUIT CLOSED (CLSD), repair open disarm sense circuit (Light Green/Orange wire). Perform TEST VER-1. If DRB-II screen does not display CIRCUIT CLOSED (CLSD), replace VTA module. Perform TEST VER-1.



## TEST 15A - REPAIRING RIGHT DOOR KEY CYLINDER CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If DRB-II status screen displays CIRCUIT CLOSED (CLSD), go to TEST 15B. If screen does not display CIRCUIT CLOSED (CLSD), disconnect right front door switch connector.

2) Connect jumper wire across both terminals of connector. Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If status screen displays CIRCUIT CLOSED (CLSD), replace right front door key cylinder switch. Perform TEST VER-1.

3) If DRB-II screen does not display CIRCUIT CLOSED (CLSD), connect jumper wire between right terminal No. 2 (Dark Green/Orange wire) of right front door switch connector and vehicle ground. Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status.

4) If screen displays CIRCUIT CLOSED (CLSD), repair switch ground wire for open to ground. Perform TEST VER-1. If DRB-II screen does not display CIRCUIT CLOSED (CLSD), connect jumper wire between terminal No. 14 (Dark Green/Orange wire) of VTA module connector and vehicle ground. DO NOT disconnect VTA module connector.

5) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If screen displays CIRCUIT CLOSED (CLSD), repair open disarm sense circuit (Dark Green/Orange wire). Perform TEST VER-1. If DRB-II screen does not display CIRCUIT CLOSED (CLSD), replace VTA module. Perform TEST VER-1.

## TEST 15B - REPAIRING DOOR KEY CYLINDER CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect left front door key cylinder switch connector. Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If DRB-II status screen does not display CIRCUIT CLOSED (CLSD), replace left front door key cylinder switch. If DRB-II screen displays CIRCUIT CLOSED (CLSD), disconnect liftgate key cylinder switch.

2) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If status screen does not display CIRCUIT CLOSED (CLSD), replace liftgate key cylinder switch. Perform TEST VER-1. If DRB-II screen displays CIRCUIT CLOSED (CLSD), disconnect right front door key cylinder switch.

3) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If DRB-II screen does not display CIRCUIT CLOSED (CLSD), replace right front door key cylinder switch. Perform TEST VER-1. If screen displays CIRCUIT CLOSED (CLSD), disconnect remote keyless entry module. See Fig. 12 in TEST 3A.

4) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If screen does not display CIRCUIT CLOSED (CLSD), replace remote keyless entry module. Perform TEST VER-1. If DRB-II screen displays CIRCUIT CLOSED (CLSD), disconnect VTA module. See Fig. 11 in TEST 2A.

5) Using DRB-II, check resistance of disarm sense circuit at terminal No. 7 (Light Green/Orange wire) of VTA module connector. If resistance is less than 5 ohms, repair disarm sense (Light Green/Orange wire) for short to ground. Perform TEST VER-1.

6) If resistance is more than 5 ohms, check resistance of disarm sense circuit (right front) at terminal No. 14 (Dark

Green/Orange wire) of VTA module connector. If resistance is less than 5 ohms, repair disarm sense (Dark Green/Orange wire) for short to ground. Perform TEST VER-1. If resistance is more than 5 ohms, replace VTA module. Perform TEST VER-1.

## TEST 16A - REPAIRING LIFTGATE KEY CYLINDER CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If DRB-II status screen displays CIRCUIT CLOSED (CLSD), go to TEST 15B. If screen does not display CIRCUIT CLOSED (CLSD), disconnect liftgate key cylinder switch connector.

2) Connect jumper wire across terminals No. 1 and 3 of connector. Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If status screen displays CIRCUIT CLOSED (CLSD), replace liftgate key cylinder switch. Perform TEST VER-1.

3) If DRB-II screen does not display CIRCUIT CLOSED (CLSD), connect jumper wire between right terminal No. 3 (Light Green/Orange wire) of liftgate key cylinder switch connector and vehicle ground. Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status.

4) If screen displays CIRCUIT CLOSED (CLSD), repair switch ground wire for open to ground. Perform TEST VER-1. If DRB-II screen does not display CIRCUIT CLOSED (CLSD), connect jumper wire between terminal No. 7 (Light Green/Orange wire) of VTA module connector and vehicle ground. DO NOT disconnect VTA module connector.

5) Using DRB-II, read DOOR KEY CYLINDER SWITCH (DR KEY CYL:) status. If screen displays CIRCUIT CLOSED (CLSD), repair open disarm sense wire (Light Green/Orange). Perform TEST VER-1. If DRB-II screen does not display CIRCUIT CLOSED (CLSD), replace VTA module. Perform TEST VER-1.

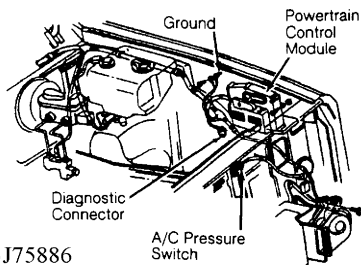
## TEST 17A - REPAIRING NO RESPONSE FROM PCM

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition to OFF. Disconnect the PCM module connector. See Fig. 14. Disconnect the VTA module connector as shown in TEST 2A, Fig. 11. Using an external ohmmeter, check resistance of CCD (+) bus circuit between terminal No. 26 (Violet/Brown wire) of PCM module connector and terminal No. 9 (Violet/Brown wire) of VTA module connector.

2) If resistance is more than 5 ohms, repair open CCD (+) bus (Violet/Brown wire). If resistance is less than 5 ohms, check resistance of CCD (-) bus circuit between terminal No. 46 (White/Black wire) of PCM module connector and terminal No. 10 (White/Black wire) of VTA module connector.

3) If resistance is more than 5 ohms, repair open CCD (-) bus (White/Black wire). Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM module. See Fig. 14. Perform TEST VER-1.



93J75886

Fig. 14: Identifying Powertrain Control Module Location

### TEST 18A - REPAIRING ARM SENSE CIRCUIT FROM REMOTE KEYLESS ENTRY MODULE

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) If malfunction is with disarm system, go to TEST 18B. Disconnect Remote Keyless Entry (RKE) module. See Fig. 12 in TEST 3A. Using DRB-II, check fused battery feed voltage at terminal "A" (Pink wire) of RKE module connector. If less than 10 volts, repair open fused battery feed circuit (Pink wire). Perform TEST VER-1.

2) If voltage is more than 10 volts, check resistance of system ground at terminal "H" (Black wire) of RKE module connector using DRB-II. If resistance is more than 15 ohms, repair open system ground (Black wire). Perform TEST VER-1. If resistance is less than 15 ohms, check resistance of arm sense circuit at terminal "F" (Pink/Orange wire) of RKE module connector using DRB-II.

3) If resistance is less than 5 ohms, repair arm sense circuit (Pink/Orange wire) for short to ground. Perform TEST VER-1. If resistance is more than 5 ohms, connect jumper wire between fused battery feed terminal "A" (Pink wire) and arm sense terminal "F" (Pink/Orange wire) of RKE module connector. If security light flashes, replace RKE module. Perform TEST VER-1.

4) If security light does not flash, disconnect VTA module. Using external ohmmeter, check resistance of arm sense circuit. Connect ohmmeter between terminal No. 6 (Pink/Orange wire) of VTA module connector and terminal "F" of RKE module connector. If resistance is more than 5 ohms, repair open arm sense (Pink/Orange wire). Perform TEST VER-1. If resistance is less than 5 ohms, replace VTA module. Perform TEST VER-1.

### TEST 18B - REPAIRING DISARM SENSE CIRCUIT FROM REMOTE KEYLESS ENTRY MODULE

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Determine if all courtesy, dome and cargo lights are functioning properly. Repair interior lights that are not functioning properly.

2) Disconnect Remote Keyless Entry (RKE) module. See Fig. 12 in TEST 3A. Using DRB-II, check courtesy light control circuit voltage at terminal "C" (Violet/Orange wire) of RKE module connector. If voltage is less than 10 volts, repair open courtesy light control circuit (Violet/Orange wire). Perform TEST VER-1. If voltage is more than 10 volts, replace RKE module. Perform TEST VER-1.

## TEST VER-1 - VERIFICATION TEST

1) Verify system operation. Ensure all doors, hood and liftgate are closed. Open driver's door. Remove ignition key from vehicle. Lock all doors with power door lock switch. Close driver's door. If instrument panel theft alarm "SET" light flashed, system is operational and verified. If "SET" light did not flash, 20 engine start cycles have not occurred or theft alarm system is malfunctioning.

2) Determine if security light is flashing. If light is not flashing, go to TEST 1A. If light is flashing, system is functioning properly

## REMOVAL & INSTALLATION

Information is not provided from manufacturer.

## WIRING DIAGRAM

See appropriate wiring diagram in the WIRING DIAGRAMS article in the ENGINE PERFORMANCE section.

# AUTO TRANS DIAGNOSIS - AW4

1993 Jeep Cherokee

AUTOMATIC TRANSMISSIONS  
Aisin Warner 4 Electronic Diagnosis

## APPLICATION

NOTE: Transmission may also be referred to as AW-4.

### TRANSMISSION APPLICATION

Vehicle Application	Transmission Model
Jeep	
1987-96 Cherokee .....	AW4
1987-92 Comanche .....	AW4
1987 Grand Wagoneer .....	AW4
1987-90 Wagoneer .....	AW4
1992 Wrangler .....	AW4

NOTE: Vehicle body code may be required when diagnosing or repairing transmission, as body code may be used instead of vehicle model name. See BODY CODE DESIGNATION table.

### BODY CODE DESIGNATION

Vehicle Model	Body Code
Cherokee .....	XJ
Comanche .....	MJ
Grand Wagoneer .....	SJ
Wagoneer .....	XJ
Wrangler .....	YJ

## DESCRIPTION

The electronic control system for the AW-4 transmission controls transmission shift points and torque converter lock-up. Electronic control system consists of Transmission Control Module (TCM), valve body solenoids, throttle position sensor, speed sensor, neutral safety switch and brake switch.

NOTE: Transmission Control Module (TCM) may be referred to as Transmission Control Unit (TCU). Neutral safety switch may be referred to as park/neutral safety switch or gear select switch.

## OPERATION

### TRANSMISSION CONTROL MODULE (TCM)

The TCM determines shift points and torque converter lock-up based on input signals received from throttle position sensor, neutral safety switch, speed sensor and brake switch. The TCM controls transmission shift points and torque converter lock-up by operating electric solenoids mounted on the valve body.

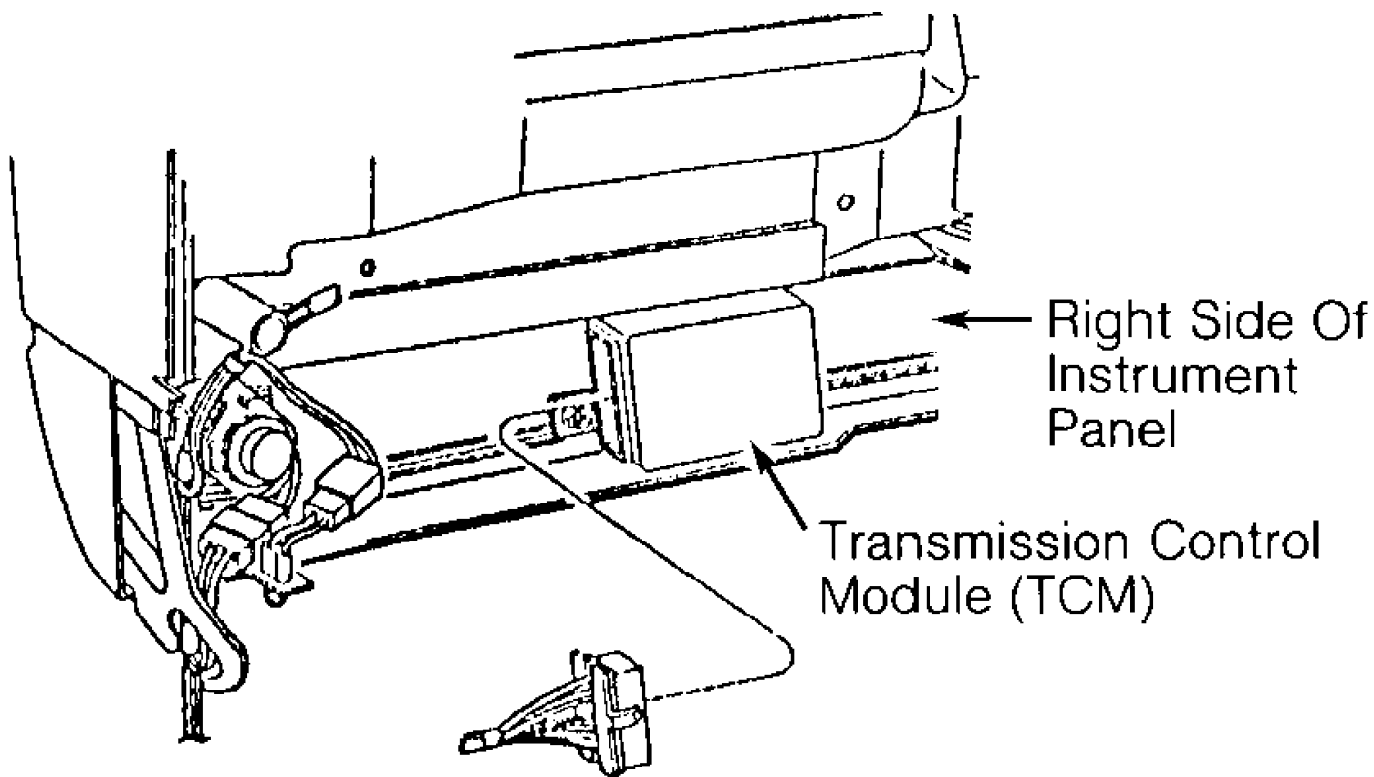
The TCM contains a self-diagnostic system used for determining an electronic component failure. The TCM self-diagnostic

system will store a diagnostic trouble code in the TCM memory if certain electronic problems exist. If electronic problem goes away, diagnostic trouble code will be erased from TCM memory after ignition has been cycled approximately 75 times.

NOTE: Diagnostic trouble code may be referred to as fault code.

Diagnostic trouble codes can be retrieved using a Diagnostic Readout Box-II (DRB-II). After repairing an electrical system problem, stored diagnostic trouble code must be cleared from TCM memory.

The TCM is located behind right side of instrument panel on Cherokee. See Fig. 1.



94F38401

Fig. 1: Transmission Control Module (TCM) I.D. (Cherokee)  
Courtesy of Chrysler Corp.

## VALVE BODY SOLENOIDS

Valve body solenoids, mounted on the valve body, are output devices controlled by signals received from the TCM. See Fig. 2. The No. 1 and 2 valve body solenoids control transmission shifts while the No. 3 valve body solenoid is used for torque converter lock-up.

When No. 1 and 2 valve body solenoids are energized, solenoid plunger moves from seat. This opens the drain port and releases line pressure. When either valve body solenoid is de-energized, plunger closes the drain port.

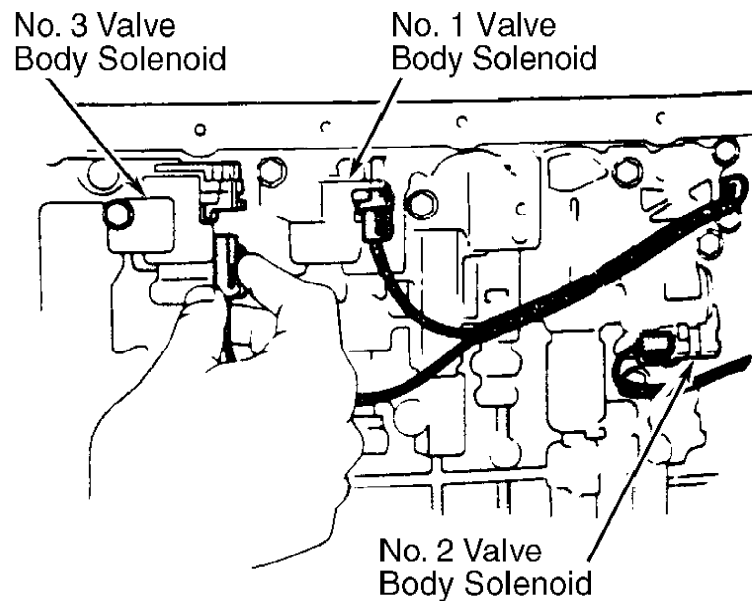
The No. 3 valve body solenoid operates in reverse. When No. 3 valve body solenoid is de-energized, solenoid plunger moves away from seat. This opens the drain port and releases line pressure. When No. 3 valve body solenoid is energized, the plunger closes the drain port.

NOTE: For valve body solenoid usage, see VALVE BODY SOLENOID APPLICATION table.

VALVE BODY SOLENOID APPLICATION (1)

Shift Lever Position	No. 1 Solenoid	No. 2 Solenoid
"D" (Drive)		
1st Gear	ON	OFF
2nd Gear	ON	ON
3rd Gear	OFF	ON
4th Gear	OFF	OFF
"3"		
1st Gear	ON	OFF
2nd Gear	ON	ON
3rd Gear	OFF	ON
"1-2"		
1st Gear	ON	OFF
2nd Gear	ON	ON
"R" (Reverse)	ON	OFF
"N" Or "P"	ON	OFF

(1) - Valve body contains 3 valve body solenoids. See Fig. 2. No. 1 and 2 valve body solenoids are used for controlling transmission shifts. No. 3 valve body solenoid is used for torque converter lock-up only.



92F13511  
Fig. 2: Identifying Valve Body Solenoids  
Courtesy of Chrysler Corp.

BRAKE SWITCH

Brake switch is an input device mounted above the brake pedal. When brake pedal is operated, brake switch delivers an input signal to the TCM. The TCM uses input signal for controlling No. 3 valve body solenoid for torque converter lock-up.

## **NEUTRAL SAFETY SWITCH**

**NOTE:** Neutral safety switch may be referred to as park/neutral safety switch or gear select switch.

Neutral safety switch is an input device mounted on the transmission manual valve shaft. Neutral safety switch delivers an input signal to TCM, indicating transmission manual valve gear position.

## **SPEED SENSOR**

Speed sensor, mounted in adapter housing or extension housing, is an input device consisting of speed sensor rotor and speed sensor. Speed sensor rotor is mounted on transmission output shaft. Input signal is delivered from speed sensor to TCM with each revolution of transmission output shaft. The TCM uses input signal for controlling transmission operation.

## **THROTTLE POSITION SENSOR (TPS)**

The TPS, mounted on throttle body, determines throttle position and delivers an input signal to TCM. The TCM uses input signal for controlling transmission upshifts and torque converter lock-up.

## **SELF-DIAGNOSTIC SYSTEM**

### **DIAGNOSTIC PROCEDURE**

When performing vehicle diagnosis:

- \* Ensure transmission fluid level is correct and fluid is neither contaminated nor aerated.
- \* Ensure shift cable is properly adjusted. Refer to the appropriate TRANSMISSION SERVICING - A/T article in this section.
- \* Ensure battery is fully charged.
- \* Perform visual inspection, ensuring all electrical connections at transmission, TCM, throttle position sensor, neutral safety switch, speed sensor and brake switch are clean and properly installed.
- \* Perform TEST 1A - VERIFICATION OF THE COMPLAINT under TROUBLE SHOOTING CHARTS in this article.
- \* Repair diagnostic trouble codes in order displayed.
- \* Always perform TEST 2A - VERIFICATION TEST after repair is completed. See TEST 2A - VERIFICATION TEST under TROUBLE SHOOTING CHARTS in this article.

### **RETRIEVING DIAGNOSTIC TROUBLE CODES**

**NOTE:** Manufacturer recommends using Chrysler's Diagnostic Readout Box-II (DRB-II) with proper cartridge for system diagnosis. Other after-market scan tools may be used for system diagnosis. The following procedure is for DRB-II scan tool usage. Use manufacturer's instruction for operating the



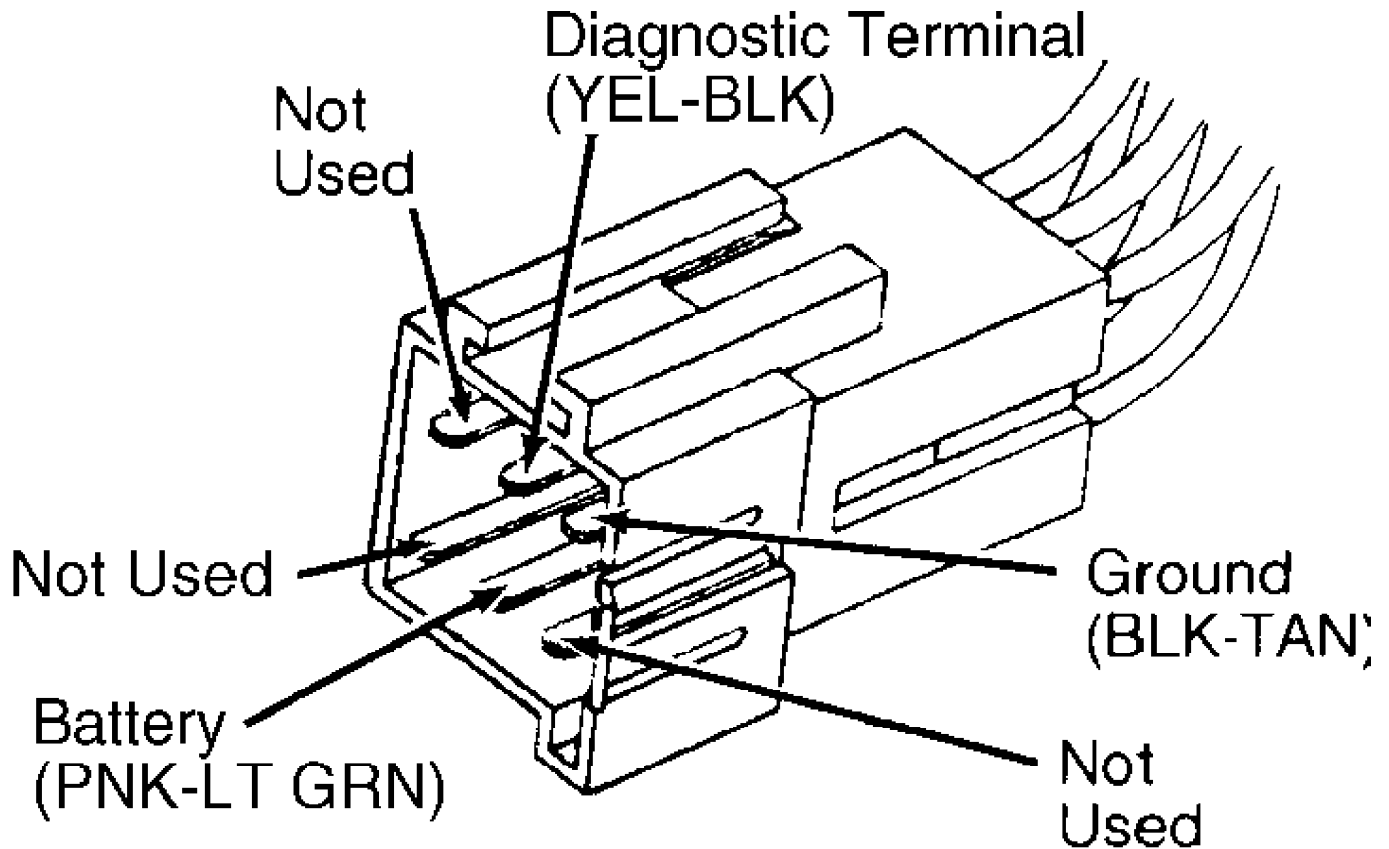
DRB-II scan tool. When retrieving diagnostic trouble codes using DRB-II, you must first enter AW4 MENU and then retrieve diagnostic trouble codes.

NOTE: Ensure TEST 1A - VERIFICATION OF THE COMPLAINT is performed when trouble shooting the vehicle. This test checks for diagnostic trouble codes with vehicle stationary and during road test. See TEST 1A - VERIFICATION OF THE COMPLAINT under TROUBLE SHOOTING CHARTS.

NOTE: The DRB-II scan tool can be used in several different modes using manufacturer's instructions to activate system components and perform several tests on transmission. See DRB-II OPERATING MODES.

#### Entering AW4 MENU

1) Ensure ignition is off. Connect DRB-II to 6-pin transmission diagnostic connector. See Fig. 3. Transmission diagnostic connector is located to the right of the steering column on driver's side of instrument panel above accelerator pedal or below glove box on passenger's side.



94F38427

Fig. 3: Diagnostic Connector & Terminals I.D. (Cherokee)  
Courtesy of Chrysler Corp.

2) Turn ignition on. Copyright date and diagnostic program will be briefly displayed. If DRB-II displays an error message, proceed to DRB-II PROBLEMS & ERROR MESSAGES. The following are possible error messages that may appear.

- \* CARTRIDGE ERROR
- \* HIGH BATTERY
- \* KEYPAD TEST FAILURE
- \* LOW BATTERY
- \* RAM TEST FAILURE

3) If no error messages appear, display will read as follows after a few seconds: 1) VEHICLES TESTED, 2) HOW TO USE, 3) CONFIGURE and 4) SELECT SYSTEM.

4) Select 4) SELECT SYSTEM to enter diagnostic system. Once in SELECT SYSTEM, select 2) TRANSMISSION to enter transmission. Display will read 1) EATX and 2) AW4.

5) Select 2) AW4. After a few seconds display will change to read AW4, VERSION 01. After a few seconds, display will read AW4 MENU, 1) SYSTEM TEST and 2) READ FAULTS. If DOWN ARROW is depressed 3 times, display will read as follows: 3) STATE DISPLAY, 4) ACTUATOR TESTS and 5) ADJUSTMENTS.

NOTE: The ACTUATOR TESTS and ADJUSTMENTS cannot be used when diagnosing the AW-4 transmission.

#### Retrieving Diagnostic Trouble Codes

1) Select 2) READ FAULTS from AW4 MENU. If no diagnostic trouble code exists, display will read as follows: AW4 FAULTS, NO FAULTS DETECTED.

2) If diagnostic trouble code exists, the following message will be displayed: 1 OF 3 FAULTS. This number will vary depending on number of diagnostic trouble codes stored in the TCM memory.

3) Diagnostic trouble code and message will be displayed. Press DOWN ARROW key to display next diagnostic trouble code. To identify diagnostic trouble code, see DIAGNOSTIC TROUBLE CODE IDENTIFICATION table.

NOTE: See TROUBLE SHOOTING CHARTS to diagnose faults indicated by trouble codes.

NOTE: Valve body solenoid diagnostic trouble code 700 may appear in a FAULT PRESENT or FAULT STORED status. Status will be displayed along with diagnostic trouble code. Diagnostic trouble code must be diagnosed depending on the status. See TEST 1A - VERIFICATION OF THE COMPLAINT under TROUBLE SHOOTING CHARTS.

#### DIAGNOSTIC TROUBLE CODE IDENTIFICATION

Trouble Code	Problem Area
700 (1) .....	Valve Body Solenoid
702 .....	Speed Sensor
703 .....	(2) Gear Select Switch
705 .....	Throttle Position Sensor
706 .....	Brake Switch
707 .....	Wrong TCM Or TCU

- (1) - Trouble code may apply to individual valve body solenoids. Valve body solenoid may be referred to as S1 for No. 1, S2 for No. 2 and S3 for No. 3.
- (2) - Gear select switch is the same as the neutral safety switch.

#### CLEARING DIAGNOSTIC TROUBLE CODES

1) Once all diagnostic trouble codes have been obtained, diagnostic trouble code(s) can be erased from TCM memory by disconnecting electrical connector from TCM for at least 15 seconds.

CAUTION: DO NOT disconnect battery, as data stored in other vehicle control modules will be lost.

2) The TCM is located behind right side of instrument panel on Cherokee. See Fig. 1.

## **DRB-II OPERATING MODES**

NOTE: The DRB-II can be operated in several different modes to perform various tests. Except for voltmeter/ohmmeter and HOW TO USE modes, all other operating modes are selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES.

### **VOLTMETER/OHMMETER MODE**

To access voltmeter/ohmmeter mode, connect Red volt-ohmmeter test lead to Red port at top right corner of DRB-II. There are 2 different ports on top of DRB-II; ensure test lead is connected to proper port. Access voltmeter or ohmmeter mode using manufacturer's instructions.

NOTE: The DRB-II is grounded through transmission diagnostic connector and only one test lead is required. When diagnosing transmission, an external volt-ohmmeter may sometimes be required.

### **HOW TO USE MODE**

1) This mode gives instructions on DRB-II usage. To enter this mode, see steps 1) through 4) of ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES. Select 2) HOW TO USE.

2) A series of screens will be displayed explaining DRB-II key usage for system diagnosing.

### **SYSTEM TEST MODE**

NOTE: SYSTEM TEST mode consists of a stationary test and a road test. The SYSTEM TEST mode must be selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES.

1) Stationary test monitors transmission system data, current valve body solenoid failures, switch failures, correct TCM application, calibration and operation. Road test checks all valve body solenoids and speed sensor.

2) Technician will be instructed to place shift lever in each gear position, starting by shifting into 1-2 position. Once transmission is in Park, brake pedal must be depressed to check brake switch.

3) After brake switch is checked, technician will be instructed to slowly depress throttle. DRB-II will display 7 asterisks (\*\*\*\*\*) corresponding to throttle position. While depressing accelerator, Throttle Position Sensor (TPS) sweeps through entire range of positions required by the TCM.

4) A corresponding asterisk will be cleared from DRB-II display as each throttle position is sensed by TCM. Several attempts may be required to clear all asterisks from the display, depending on

how fast accelerator is depressed.

5) After throttle position is checked, technician will be instructed to drive the vehicle. The DRB-II will indicate if a requested action is seen by the TCM. If technician is requested to perform a particular operation and TCM does not acknowledge the action, press ENTER key to continue testing.

6) The TCM will instruct technician to accelerate vehicle at light throttle to ensure transmission shifts through all gears, indicating proper valve body solenoid operation.

7) During road test, ensure vehicle can be accelerated slowly and evenly to allow transmission to enter all gear ranges without downshifting or braking. If a failure is sensed, a diagnostic trouble code will be displayed on DRB-II.

**NOTE:** If TCM senses a failure, control logic activates a specified valve body solenoid to obtain a certain gear depending on failure. Because transmission diagnostic trouble codes are displayed one at a time, multiple diagnostic trouble codes must be identified by retesting transmission.

## STATE DISPLAY MODE

**NOTE:** STATE DISPLAY mode must be selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES. Select 3) STATE DISPLAY on DRB-II.

### Module Information

When selecting module information option, the TCM version will be indicated by a 2-digit number. Information can be used to verify proper TCM application.

### Sensor

1) When selecting sensor option, TPS and RPM indications will be shown. The TPS indicator will display a 7 segment bar graph, indicating TPS position and throttle plate angle.

2) A properly operating TPS should indicate 7 segments through full throttle travel. The RPM indicator will display transmission output shaft revolutions per minute.

### Brake Switch Or Input/Output

Display indicates brake switch status, indicating whether brake pedal is applied or released. Display also indicates shift lever position, whether a valve body solenoid is on or off and present transmission operating gear.

## DRB-II PROBLEMS & ERROR MESSAGES

### CARTRIDGE ERROR

1) If CARTRIDGE ERROR message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If CARTRIDGE ERROR message is displayed, replace DRB-II cartridge and proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

### HIGH BATTERY

If HIGH BATTERY message is displayed, use external voltmeter to check battery voltage at battery terminals. If battery voltage is 11.7-13.0 volts, replace DRB-II. If battery voltage is not 11.7-13.0

volts, check charging system.

## KEYPAD TEST FAILURE

1) If KEYPAD TEST FAILURE message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If KEYPAD TEST FAILURE message is not displayed, proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

## LOW BATTERY

If LOW BATTERY message is displayed, use external voltmeter to check battery voltage at battery terminals. If battery voltage is 11.7-13.0 volts, replace DRB-II. If battery voltage is not 11.7-13.0 volts, check charging system.

## RAM TEST FAILURE

1) If RAM TEST FAILURE message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If RAM TEST FAILURE message is not displayed, proceed with diagnostics. If RAM TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

## COMPONENT TESTING

### BRAKE SWITCH

Brake switch is mounted above brake pedal. When brake pedal is operated, brake switch delivers an input signal to TCM. The TCM uses input signal for controlling No. 3 valve body solenoid for torque converter lock-up. No other information is available from manufacturer.

NOTE: For proper brake switch adjustment, see BRAKE SWITCH under REMOVAL & INSTALLATION.

### NEUTRAL SAFETY SWITCH

NOTE: Neutral safety switch may be referred to as park/neutral or gear select switch. For proper neutral safety switch adjustment, see NEUTRAL SAFETY SWITCH under REMOVAL & INSTALLATION.

Disconnect electrical connector. Note terminal identification. See Fig. 4. Using ohmmeter, check continuity between specified terminals in relation to shift lever position. See NEUTRAL SAFETY SWITCH CONTINUITY SPECIFICATIONS table. Replace neutral safety switch if continuity is not as specified.

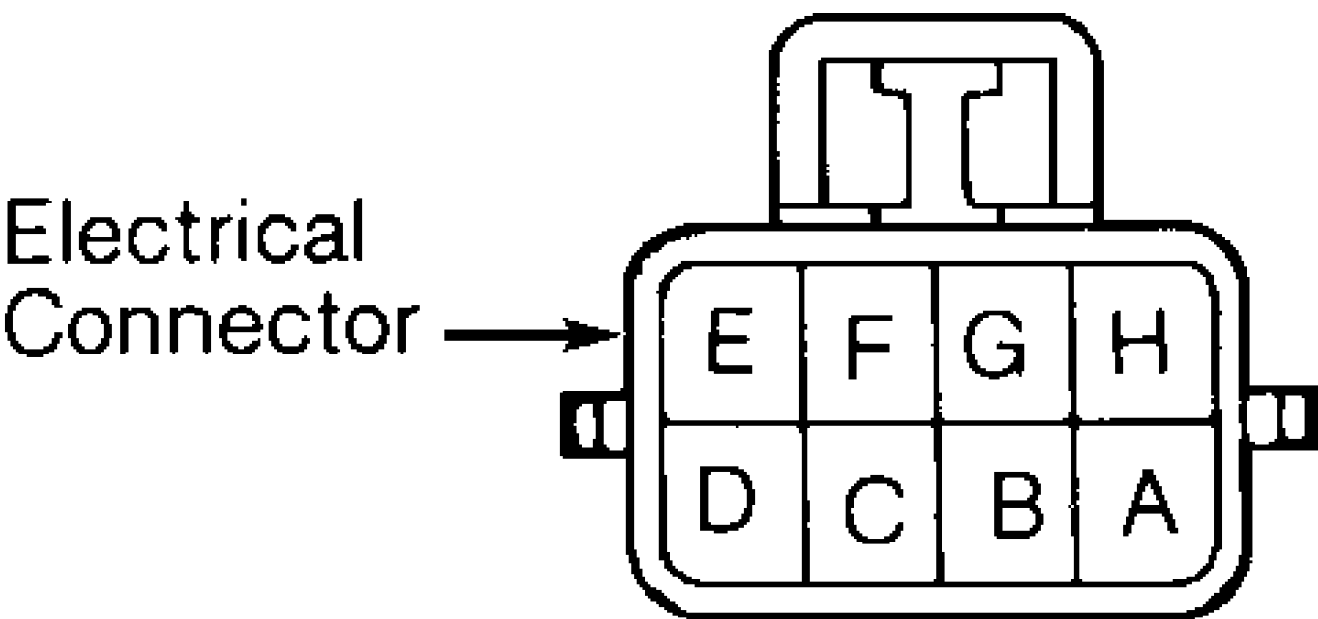
#### NEUTRAL SAFETY SWITCH CONTINUITY SPECIFICATIONS

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Shift Lever Position	Continuity Between Terminals
-------------------------	---------------------------------

Park .....	"B" & "C"
Reverse .....	"A" & "E"
Neutral .....	"B" & "C"
Drive .....	(1)
3 .....	"A" & "G"
1-2 .....	"A" & "H"

(1) - No continuity should exist between any terminals.



92H13513

Fig. 4: Identifying Neutral Safety Switch Terminals  
 Courtesy of Chrysler Corp.

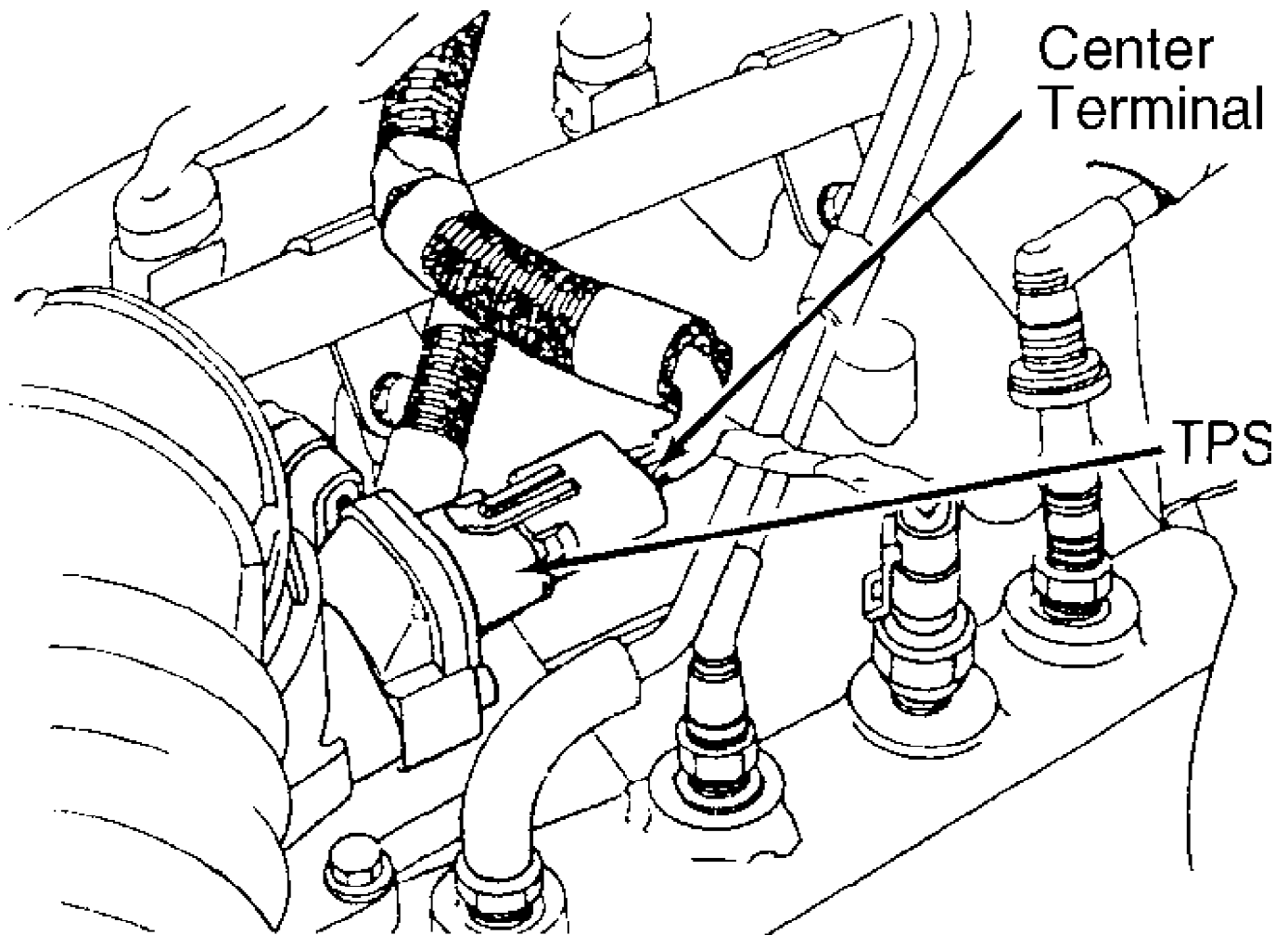
### SPEED SENSOR

- 1) Disconnect electrical connector at speed sensor located on adapter housing or extension housing. Connect ohmmeter leads between speed sensor electrical terminals.
- 2) Rotate transmission output shaft and note ohmmeter reading. Ohmmeter needle should fluctuate to indicate speed sensor operation. Replace speed sensor if no reading is obtained.

### THROTTLE POSITION SENSOR (TPS)

NOTE: Digital voltmeter must be used to check TPS.

- 1) Note location of TPS electrical connector. See Fig. 5. Turn ignition on. Using digital voltmeter, check output voltage at center terminal with throttle plate closed (idle position) and wide open (full throttle).
- 2) With throttle plate closed (idle position), output voltage should be greater than 200 millivolts. With throttle plate wide open (full throttle), output voltage should be less than 4.8 volts.
- 3) Ensure output voltage gradually increases as throttle plate is moved from closed to wide open throttle. If no voltage exists, check for defective wiring circuits or connections. Replace TPS if defective.



**92113514**

Fig. 5: Identifying TPS Electrical Connector  
Courtesy of Chrysler Corp.

### VALVE BODY SOLENOID

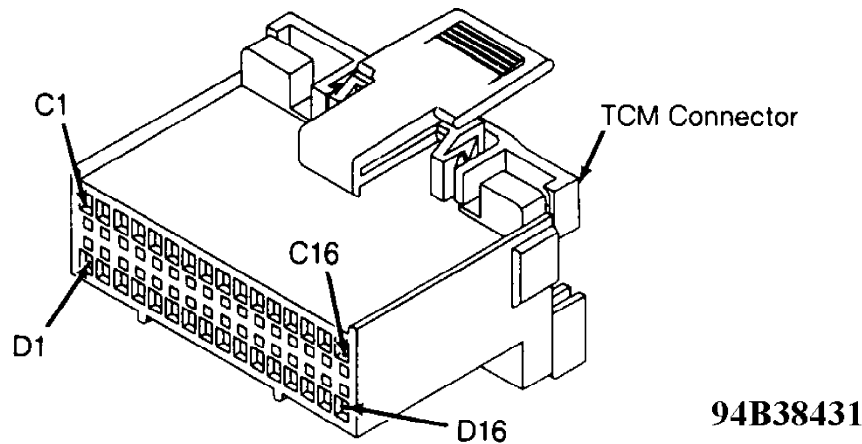
With oil pan removed, disconnect electrical connector from valve body solenoid. Using ohmmeter, check resistance between valve body solenoid electrical terminal and solenoid mounting bracket. Replace valve body solenoid if resistance is not 11-15 ohms.

### TROUBLE SHOOTING CHARTS & CODE CHARTS

NOTE: Following trouble shooting charts and illustrations are courtesy of Chrysler Corp. Always start by performing TEST 1A - VERIFICATION OF THE COMPLAINT. When diagnosing transmission, it may be necessary to verify TCM connector terminals, circuits and function, See Fig. 6.

NOTE: When using trouble shooting charts, Transmission Control Module (TCM) may be referred to as Transmission Control Unit (TCU). Diagnostic trouble code may be referred to as fault code. Neutral safety switch may be referred to as

park/neutral or gear select switch.



CHEROKEE

CAV ...	CIRCUIT .....	FUNCTION
C1-C2		Not Used
C3	505 TN/BK	Trans Speed Sensor
C4	137 YL/BK	Auto Trans Diagnostic
C5-C7		Not Used
C8	506 LG/BK	Low (1-2) Input
C9	507 GY/BK	Drive (3) Input
C10	K29 WT/PK	Brake Input
C11		Not Used
C12-C13		Not Used
C14	508 WT/BK	S3 Solenoid (Converter Lockup)
C15	509 VT/WT	S2 Solenoid
C16	510 DB/WT	S1 Solenoid
D1		Not Used
D2	K22 OR/DB	Throttle Position Sensor
D3	K4 BK/LB	TPS Signal Ground
D4-D6		Not Used
D7	Z12 BK/TN	Power Ground
D8-D13		Not Used
D14	A14 RD	Battery
D15		Not Used
D16	T17 YL	Ignition (Run/On)

GRAND CHEROKEE

CAV...	CIRCUIT .....	FUNCTION
C1-C2		Not Used
C3	T14 LG/WT	Trans Speed Sensor
C4	D82 BK/YL	Auto Trans Diagnostic
C5-C7		Not Used
C8	T25 LG	Low (1-2) Input
C9	T50 DG	Drive (3) Input
C10	L53 BR	Brake Input
C11-C13		Not Used
C14	T20 LB/BR	S3 Solenoid (Converter Lockup)
C15	T59 PK	S2 Solenoid
C16	T60 BR/YL	S1 Solenoid
D1		Not Used
D2	K22 OR/DB	Throttle Position Sensor
D3	K4 BK/LB	TPS Signal Ground
D4-D6		Not Used
D7	Z1 BK	Power Ground
D8-D13		Not Used
D14	A14 RD/WT	Battery
D15		Not Used
D16	F86 LB/RD	Ignition (Run/On)

Fig. 6: TCM Connector Terminals I.D., Circuits & Functions  
Courtesy of Chrysler Corp.

TEST 1A - VERIFICATION OF THE COMPLAINT

NOTE: ALWAYS start diagnosis with the most recent code.

1) Begin your testing of the transmission with a thorough visual inspection.



2) Connect the DRB-II to the transmission diagnostic connector. See RETRIEVING FAULT CODES under SELF-DIAGNOSTIC SYSTEM for diagnostic connector location.

CAUTION: If the vehicle is in 3rd or OD position and feels like it is stuck in 3rd or jumping from 2-1 or 3-1, perform TEST 10A - TESTING FOR INTERMITTENT SPEED SENSOR test below.

3) With the DRB-II, perform SYSTEM TEST. See SYSTEM TEST MODE under DRB-II OPERATING MODES.

4) The DRB-II will instruct you to do some actions during the System Test. The DRB-II will then look for the action to happen and automatically go to the next test function. If you perform the required action and the DRB-II does not move to the next function, press ENTER. The DRB-II will continue the testing.

5) When the DRB-II states "VEHICLE DRIVE", the vehicle must be driven at a speed above 4 miles per hour to ensure accurate testing of the vehicle speed sensor. Afterwards, the DRB-II will display any fault codes that may be present.

6) When the system test is complete, if there are any fault codes present, the DRB-II will automatically display the code(s).

7) There are two types of faults for the transmission solenoids. They are displayed as "FAULT STORED" and "FAULT PRESENT". Note that the tests are different in the chart below.

8) Perform the tests shown below in response to the indicated fault codes.

NOTE: ALWAYS start diagnosis with the most recent code.

## CODE-TO-TEST MENU

### CODE-TO-TEST MENU

Code:	Solenoid Affected:	Fault Status:	Perform:
None	None Affected	No Faults	Test 2A
700	Solenoid No. 1	Fault Present	Test 4A
700	Solenoid No. 1	Fault Stored	Test 3A
700	Solenoid No. 2	Fault Present	Test 4B
700	Solenoid No. 2	Fault Stored	Test 3A
700	Solenoid No. 3	Fault Present	Test 4C
700	Solenoid No. 3	Fault Stored	Test 3A
702	Speed Sensor Fault		Test 5A
703	Gear Select Fault		Test 6A
705	TPS Fault		Test 7A
708	Wrong TCU		Test 9A

## TEST 2A - VERIFICATION TEST

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

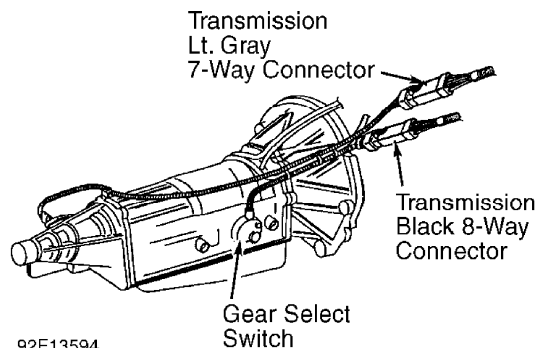
This test verifies the correct operation of the AW4 transmission. It must be performed after finding no faults using the DRB-II, and after a vehicle repair has been made.

- 1) Turn ignition key to "OFF".
- 2) Hold the MODE key and press the ATM key on the DRB-II at the same time to restart the DRB-II.
- 3) Turn ignition key to "ON".
- 4) Reconnect all previously disconnected connectors.
- 5) Verify that the AW4 transmission control unit is properly mounted.
- 6) Make sure the transmission fluid is at the proper level. Check the fluid with the transmission temperature hot, the vehicle on level ground, and the gear selector in neutral.
- 7) If any repairs have been made, test the vehicle as instructed in TEST 1A - VERIFICATION OF THE COMPLAINT, and read faults using the DRB-II. If there are any fault messages present, repeat TEST 1A - VERIFICATION OF THE COMPLAINT.

### TEST 3A - STORED DIAGNOSTIC TROUBLE CODES TEST

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

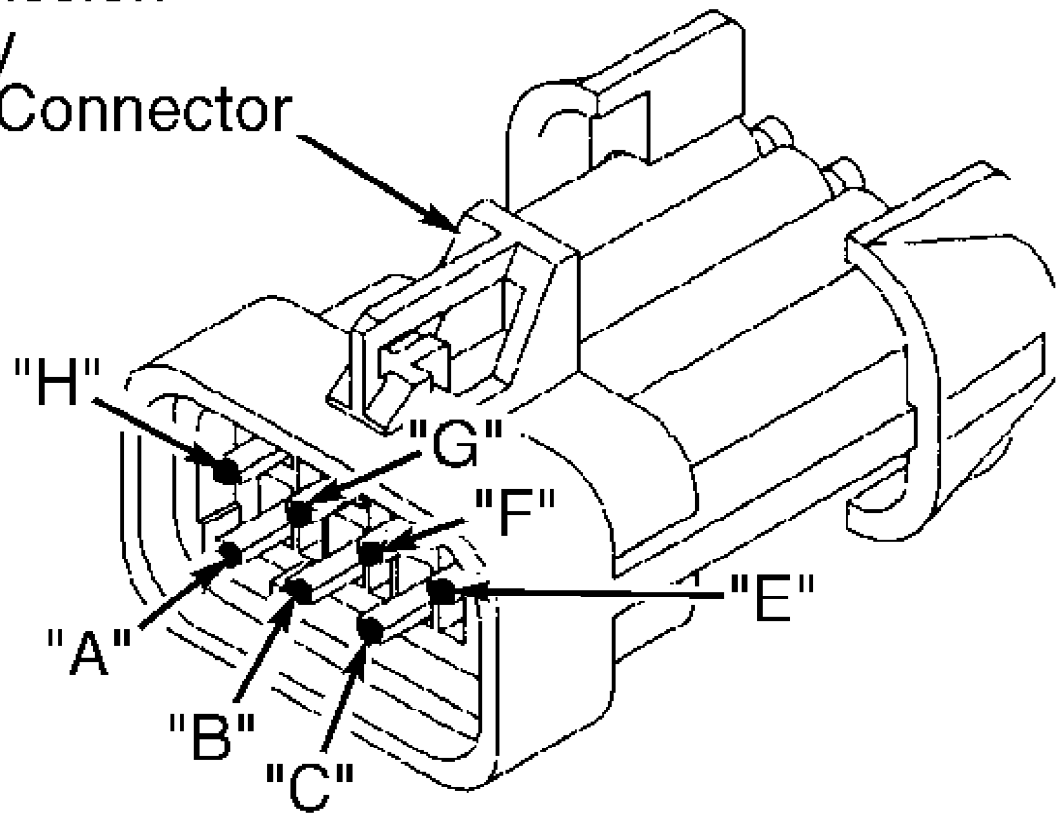
- 1) At this point, the Visual Inspection has been performed, a "FAULT STORED" code has been found and the vehicle has been test driven. The fault code is not "FAULT PRESENT", so it cannot be considered a CURRENT or HARD fault.
- 2) All solenoid circuits are in the same harness and a common ground wire is used for the solenoids. Use the following figures to identify the harness and connector to inspect. See Fig. 7 and 8. if all 3 solenoid faults are present, repair the Black wire (Cherokee) ground wire open condition.
- 3) Carefully inspect the entire suspected circuit. Pay particular attention to connectors, corrosion, accident damage, and improper or missing parts.
- 4) If any problems are found, make the appropriate repair. Then perform TEST 1A using the DRB-II.
- 5) Erase fault codes.
- 6) If no problems are found, perform the SYSTEM TEST using the DRB-II. Re-check for fault codes. If there are no fault codes, perform TEST 2A - VERIFICATION TEST. If fault code(s) return, perform TEST 1A - VERIFICATION OF THE COMPLAINT.



92F13594

Fig. 7: Test 3A - Location of 7-Way Connector

# Transmission Lt. Gray 7-Way Connector



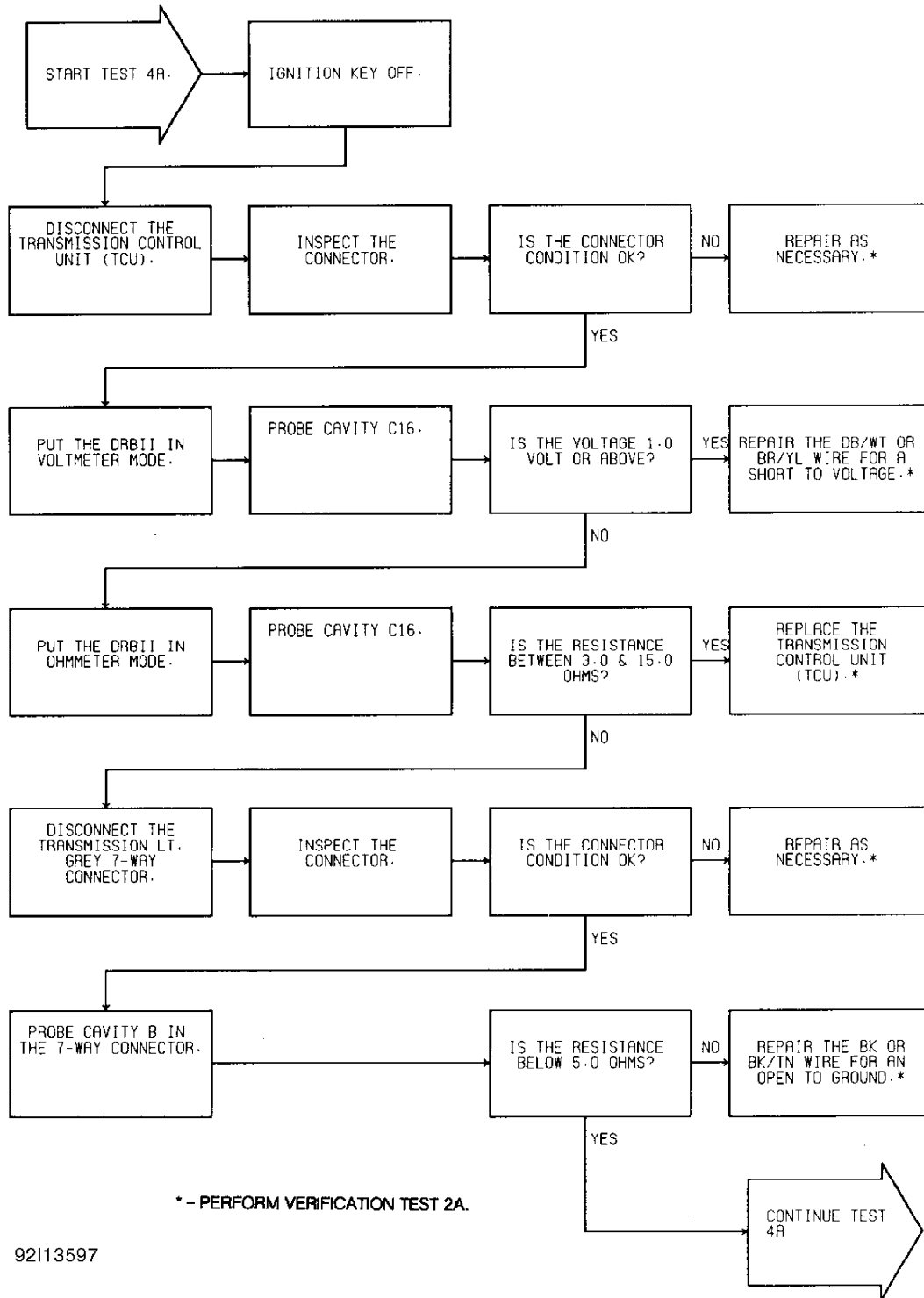
A	B	C	E	F	G	H
BK/YL	BK/TN	TN/WT	WT/BK	VT/WT	DB/WT	BK/RD

92G13595

Fig. 8: Test 3A - View of 7-Way Connector (Cherokee)

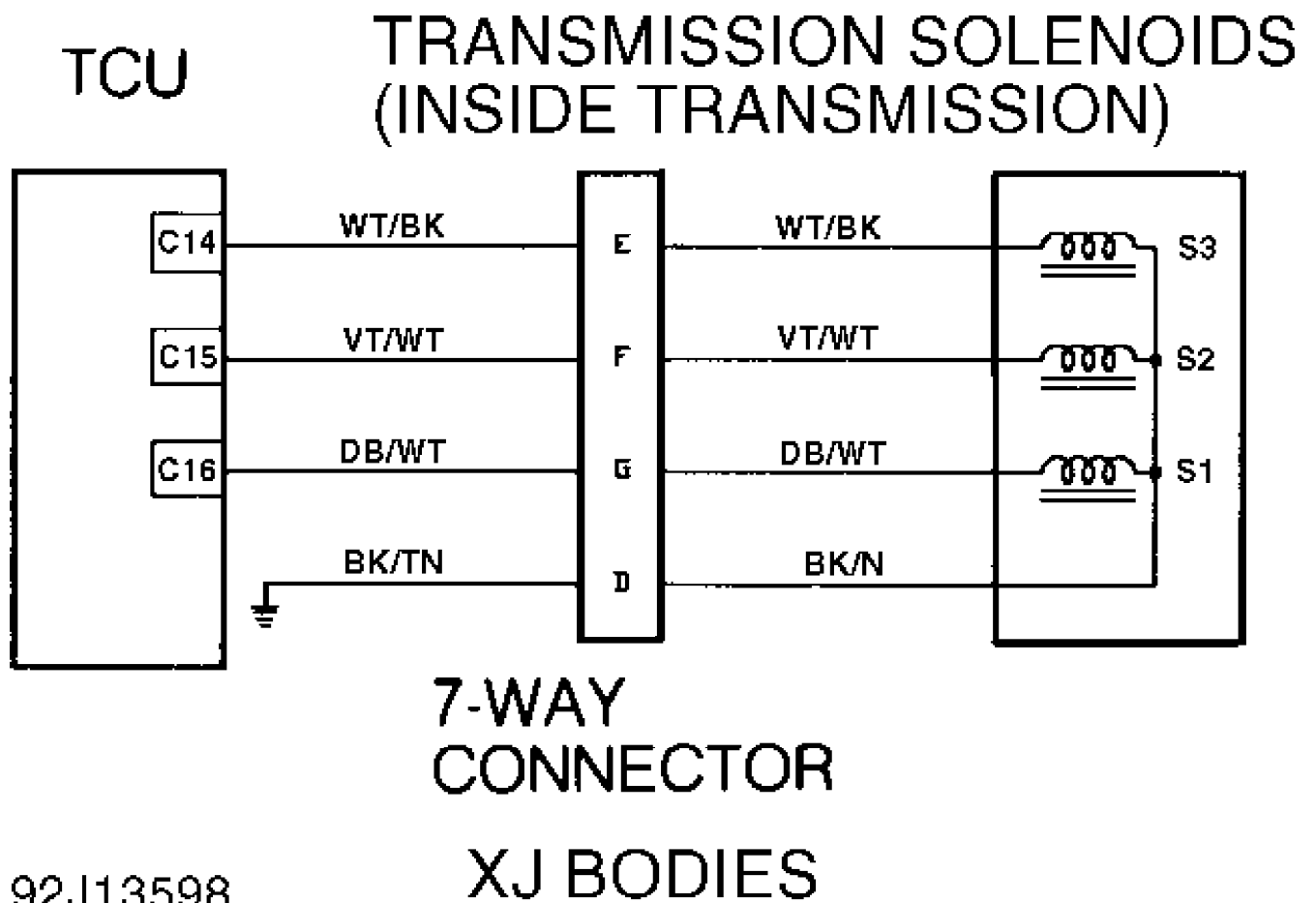
TEST 4A - CODE 700 - S1 SOLENOID CIRCUIT

Perform TEST 1A before proceeding.



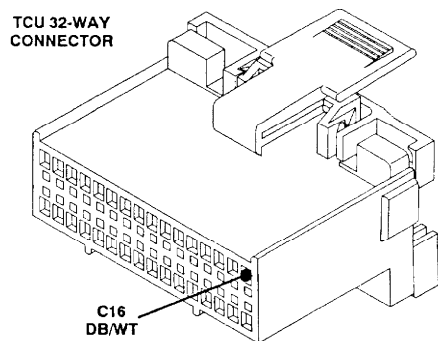
92113597

Fig. 9: Test 4A - Code 700, Flow Chart (1 of 2)



**92J13598**

Fig. 10: Test 4A - Code 700, Schematic (Cherokee)



**ZJ Body: BR/YL**

**92D13600**

Fig. 11: Test 4A - Code 700, TCU 32-Way Connector (Cavity 16)

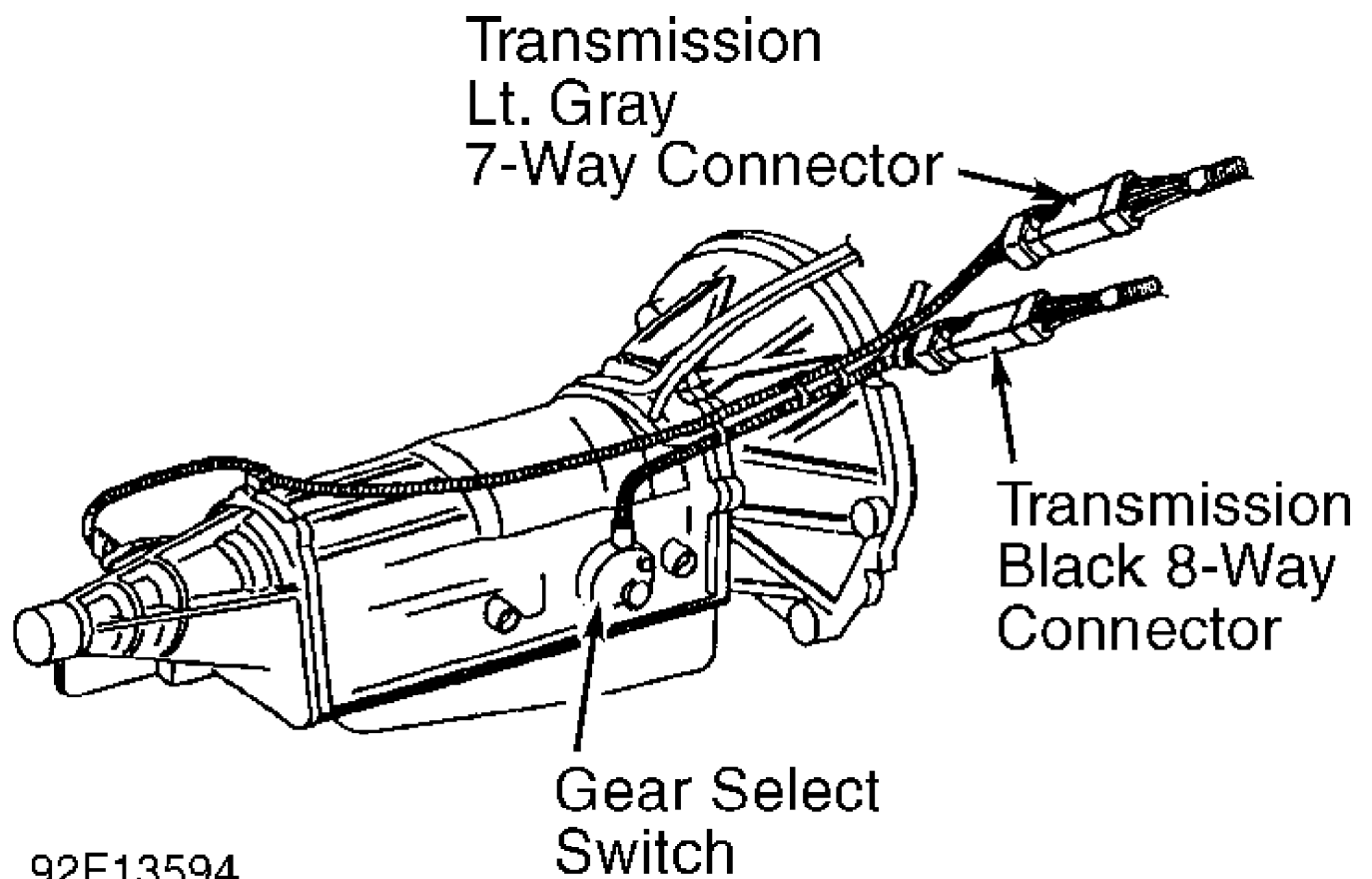


Fig. 12: Test 4A - Code 700, Location of 7-Way Connector

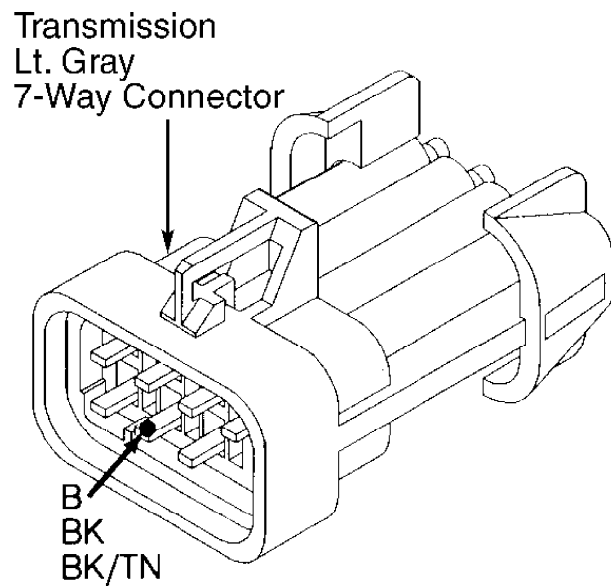
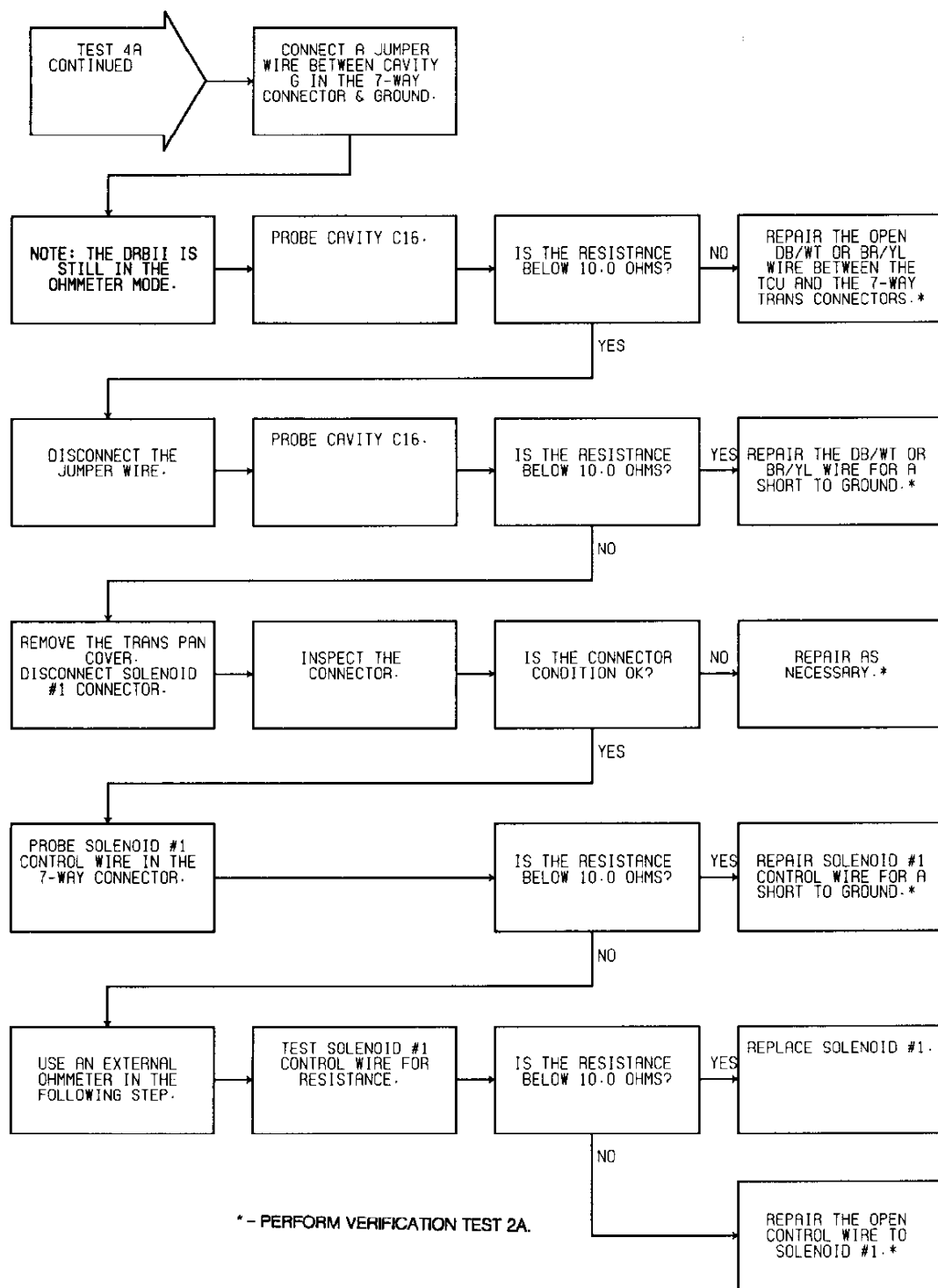


Fig. 13: Test 4A - Code 700, Location of Pin "B" (Ground)



**NOTE: See TEST 4A (1 OF 2) for wiring diagram.**

92F13602

Fig. 14: Test 4A - Code 700, Flow Chart (2 of 2)

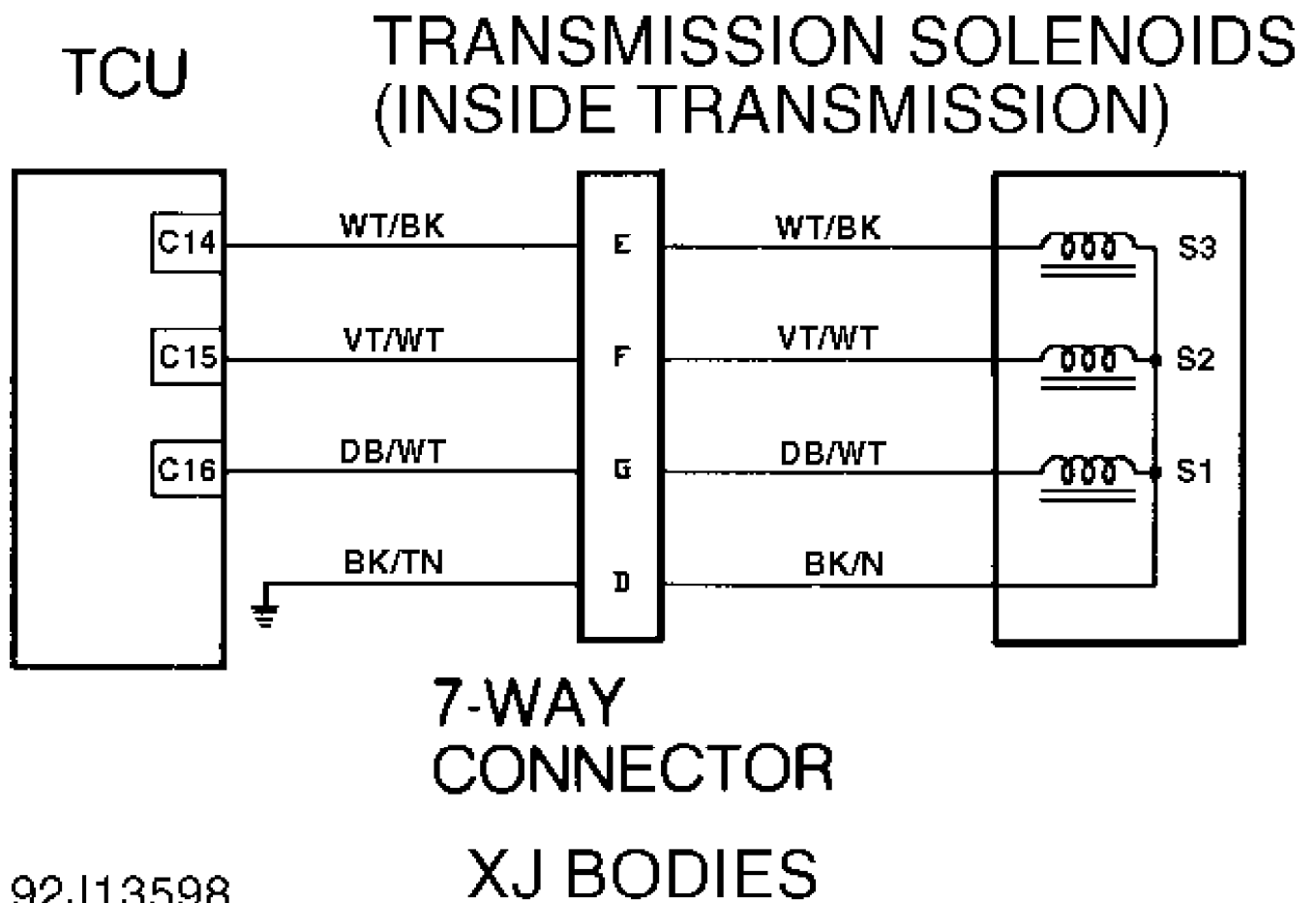
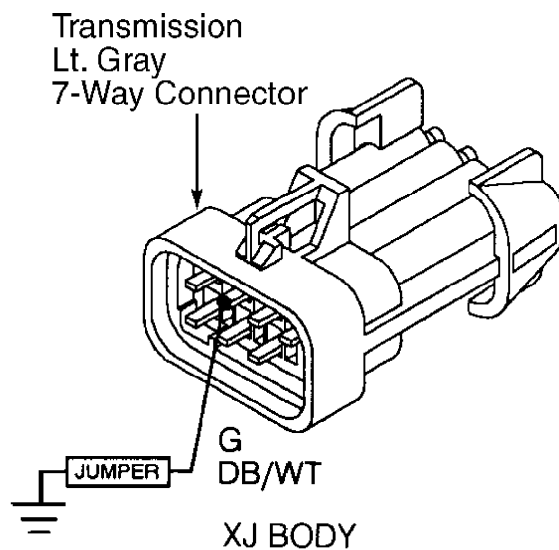


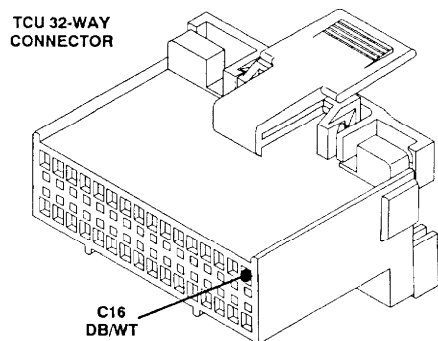
Fig. 15: Test 4A - Code 700, Schematic (Cherokee)



92G13603

Fig. 16: Test 4A - 7-Way Connector Cavity "G" (Cherokee)





92D13600

ZJ Body: BR/YL

Fig. 17: Test 4A - Code 700, TCU 32-Way Connector (Cavity 16)

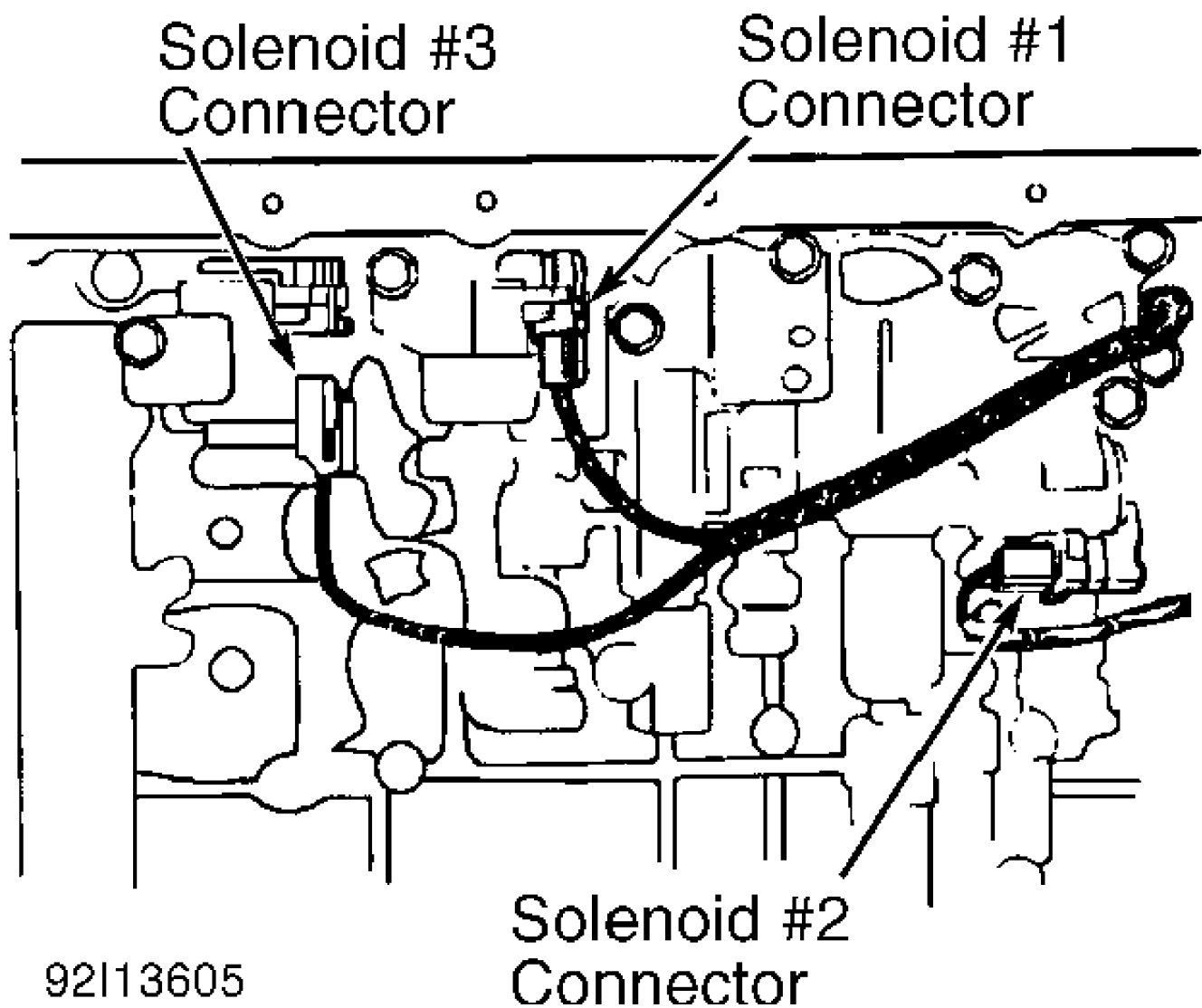
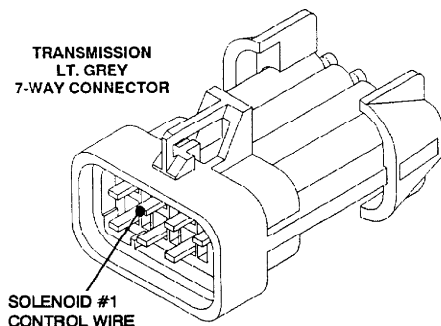


Fig. 18: Test 4A - Code 700, Location of Solenoids



CAV	MJ/XJ	ZJ
G	DB/WT	BR/YL

Fig. 19: Test 4A - Code 700, Solenoid No. 1 Wire (Cavity "G")<sup>92J13606</sup>

Transmission  
Lt. Gray  
7-Way Connector

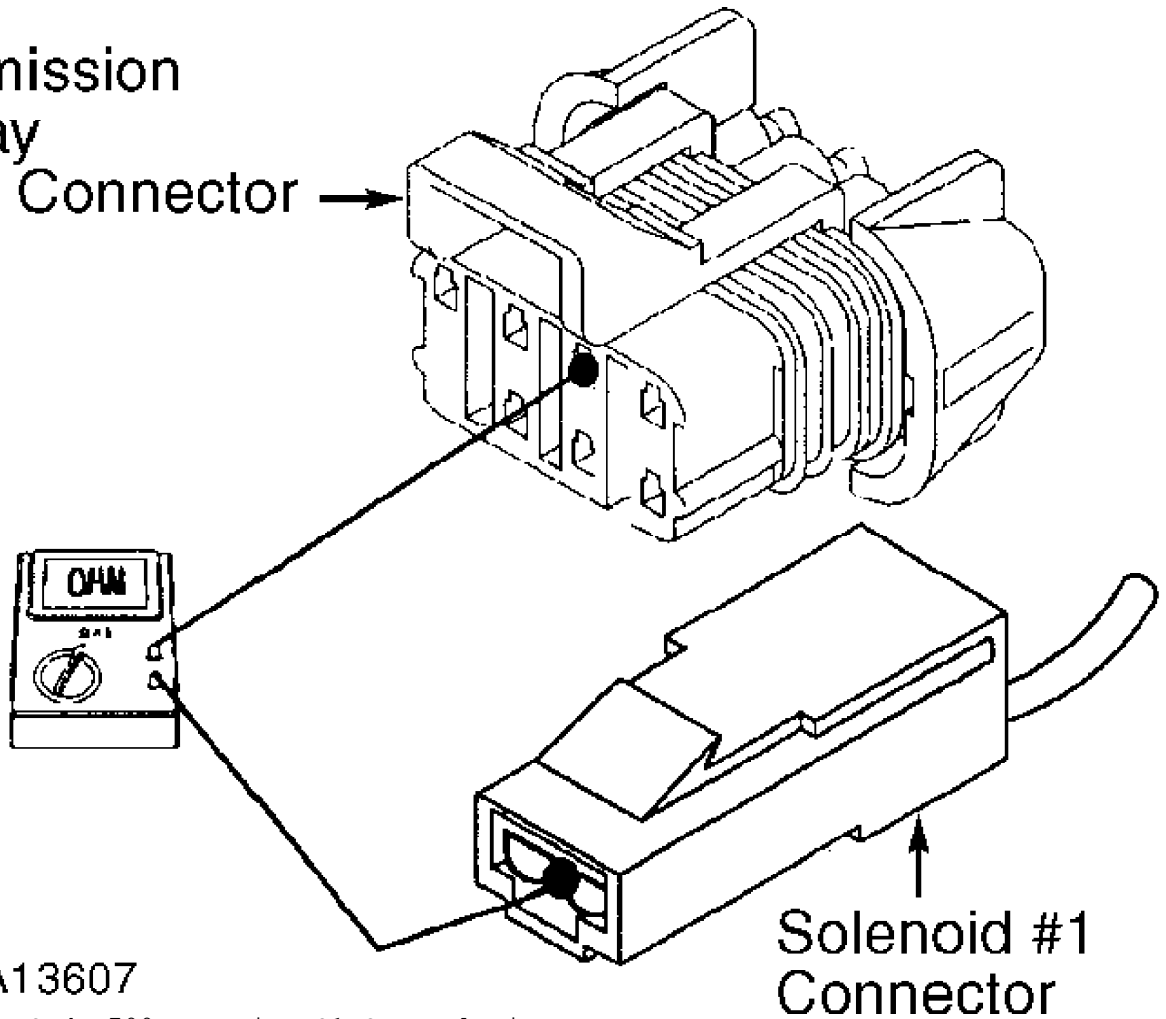


Fig. 20: Test 4A - Code 700, Testing S1 Control Wire

TEST 4B - CODE 700 - S2 SOLENOID CIRCUIT

Perform TEST 4A before proceeding.

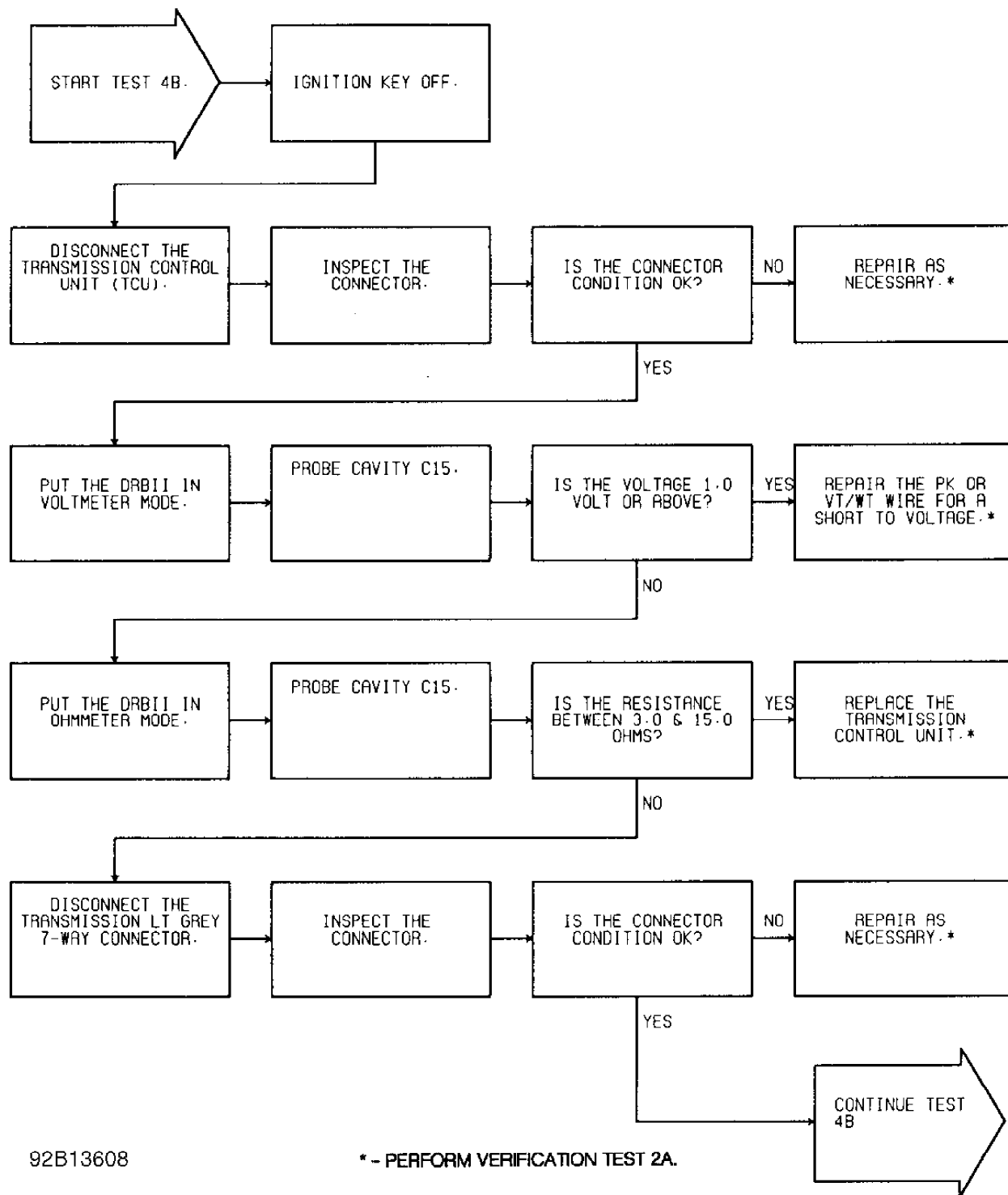
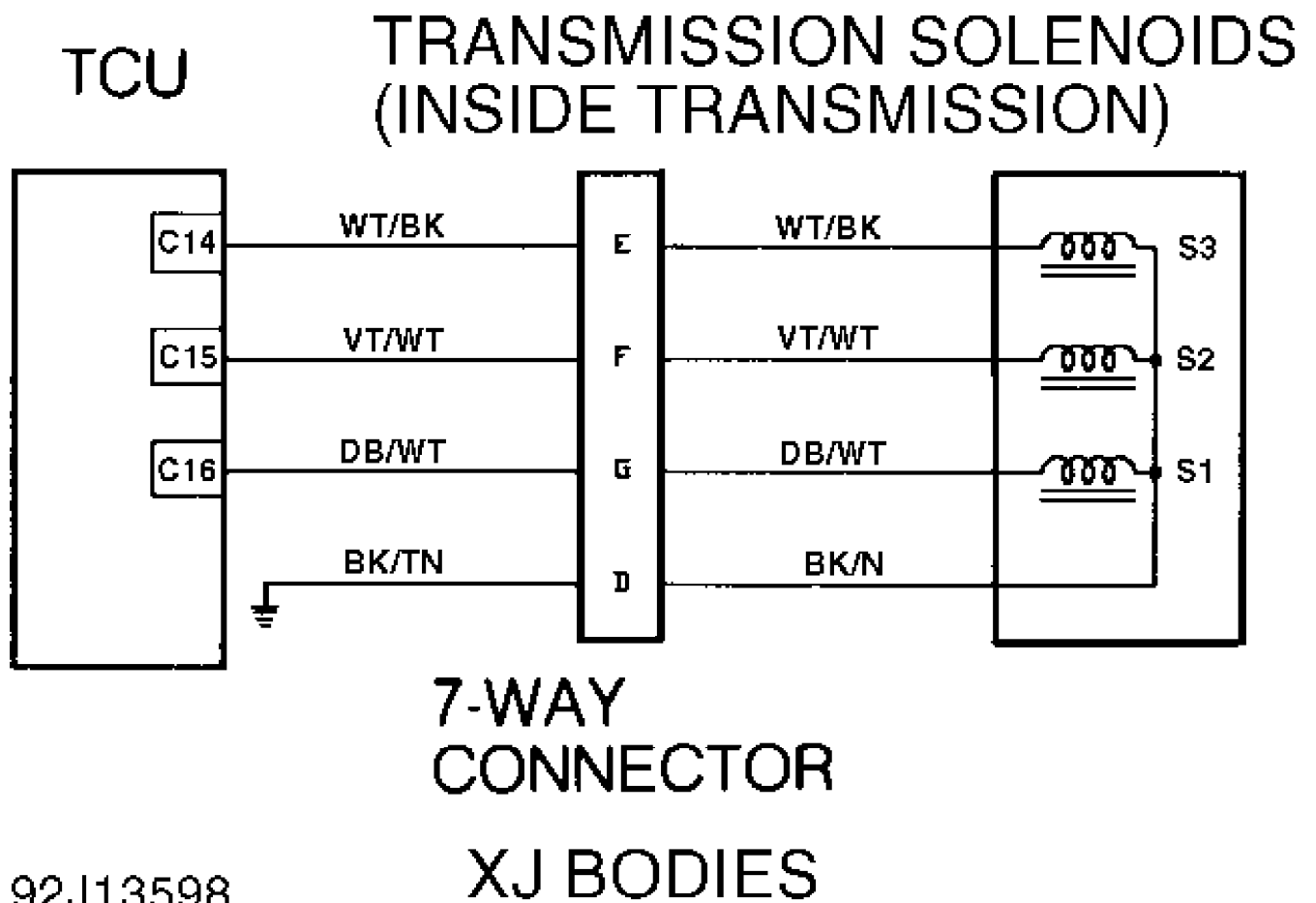
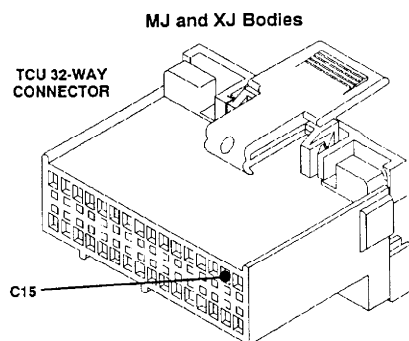


Fig. 21: Test 4B - Code 700, Flow Chart (1 of 2)



92J13598

Fig. 22: Test 4B - Code 700, Schematic (Cherokee)



CAV	MJ/XJ	ZJ
C15	VT/WT	PK

92C13609

Fig. 23: Test 4B - Code 700, TCU 32-Way Connector (Cavity 15)

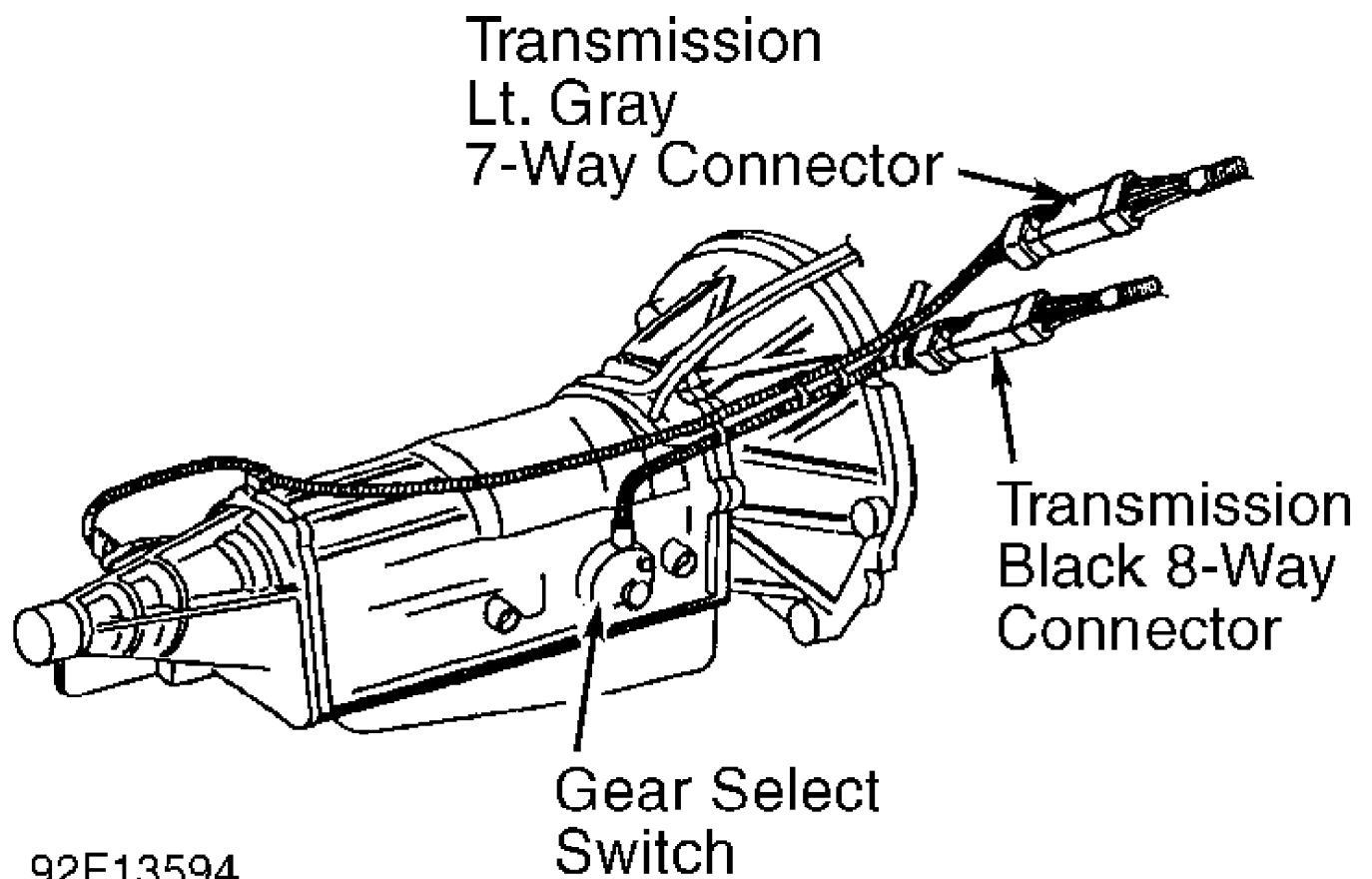
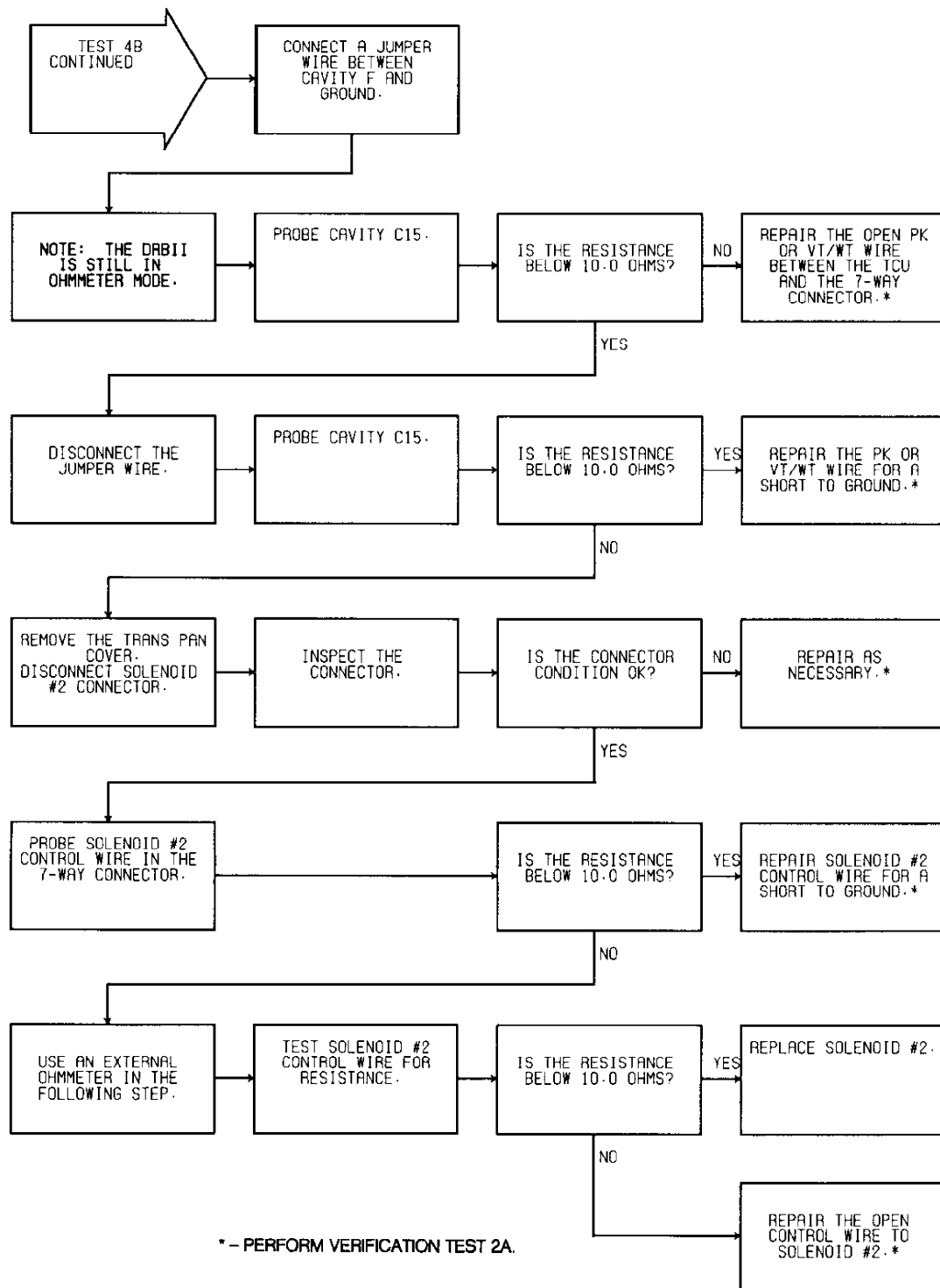


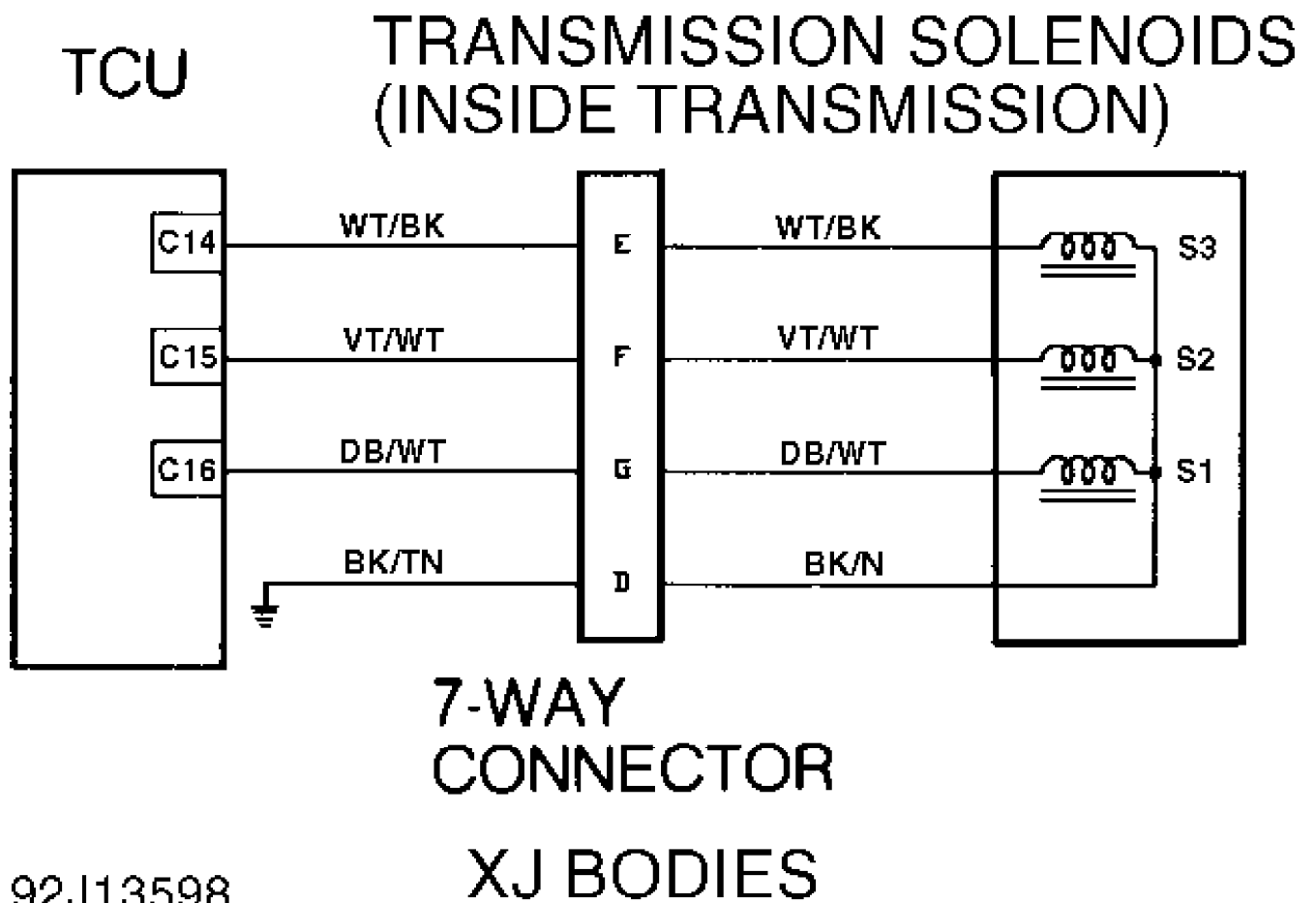
Fig. 24: Test 4B - Code 700, Location of 7-Way Connector



**NOTE: See TEST 4B (1 OF 2) for wiring diagram.**

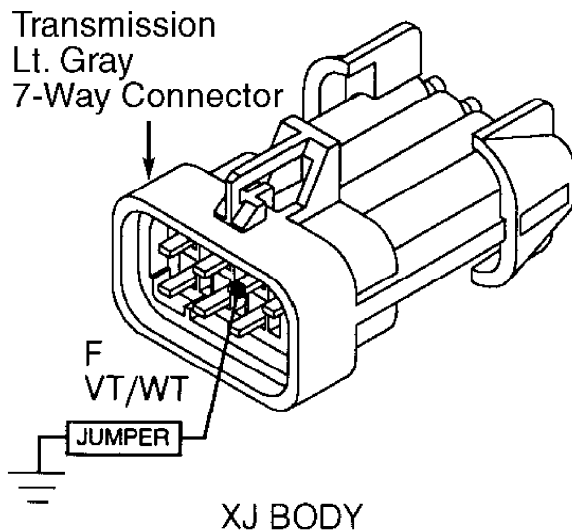
92F13610

Fig. 25: Test 4B - Code 700, Flow Chart (2 of 2)



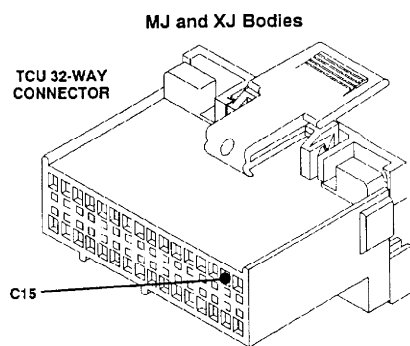
92J13598

Fig. 26: Test 4B - Code 700, Schematic (Cherokee)



92G13611

Fig. 27: Test 4B - 7-Way Connector Cavity "F" (Cherokee)



CAV	MJ/XJ	ZJ
C15	VT/WT	PK

92C13609

Fig. 28: Test 4B - Code 700, TCU 32-Way Connector (Cavity 15)

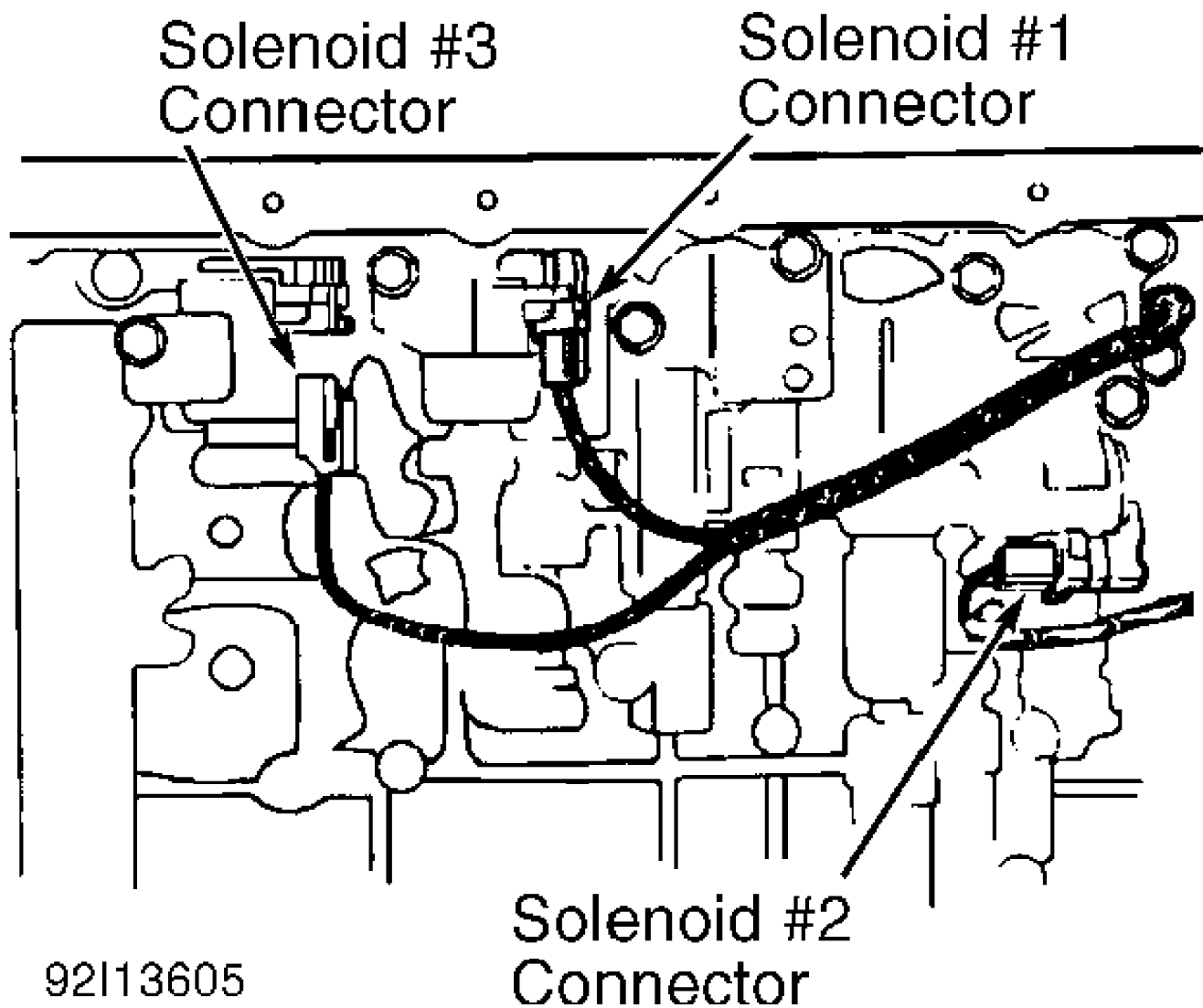
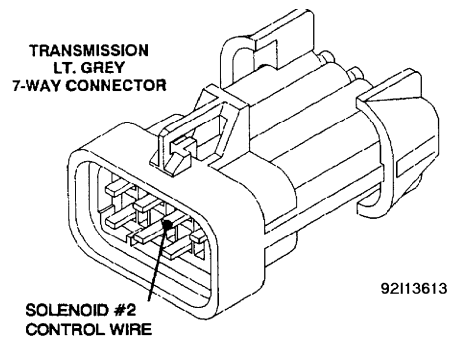


Fig. 29: Test 4B - Code 700, Location of Solenoids





CAV	MJ/XJ	ZJ
F	VT/WT	PK

Fig. 30: Test 4B - Code 700, Solenoid No. 1 Wire (Cavity "F")

Transmission  
Lt. Gray  
7-Way Connector

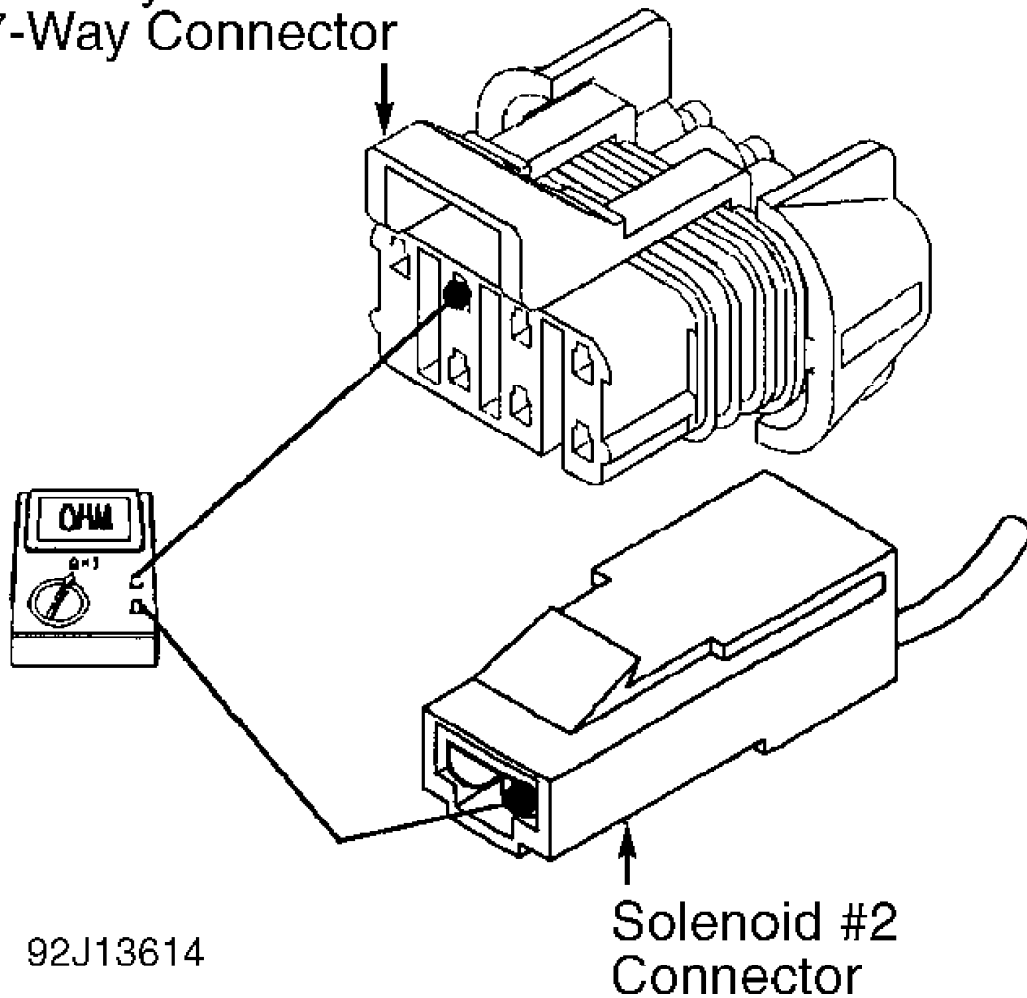
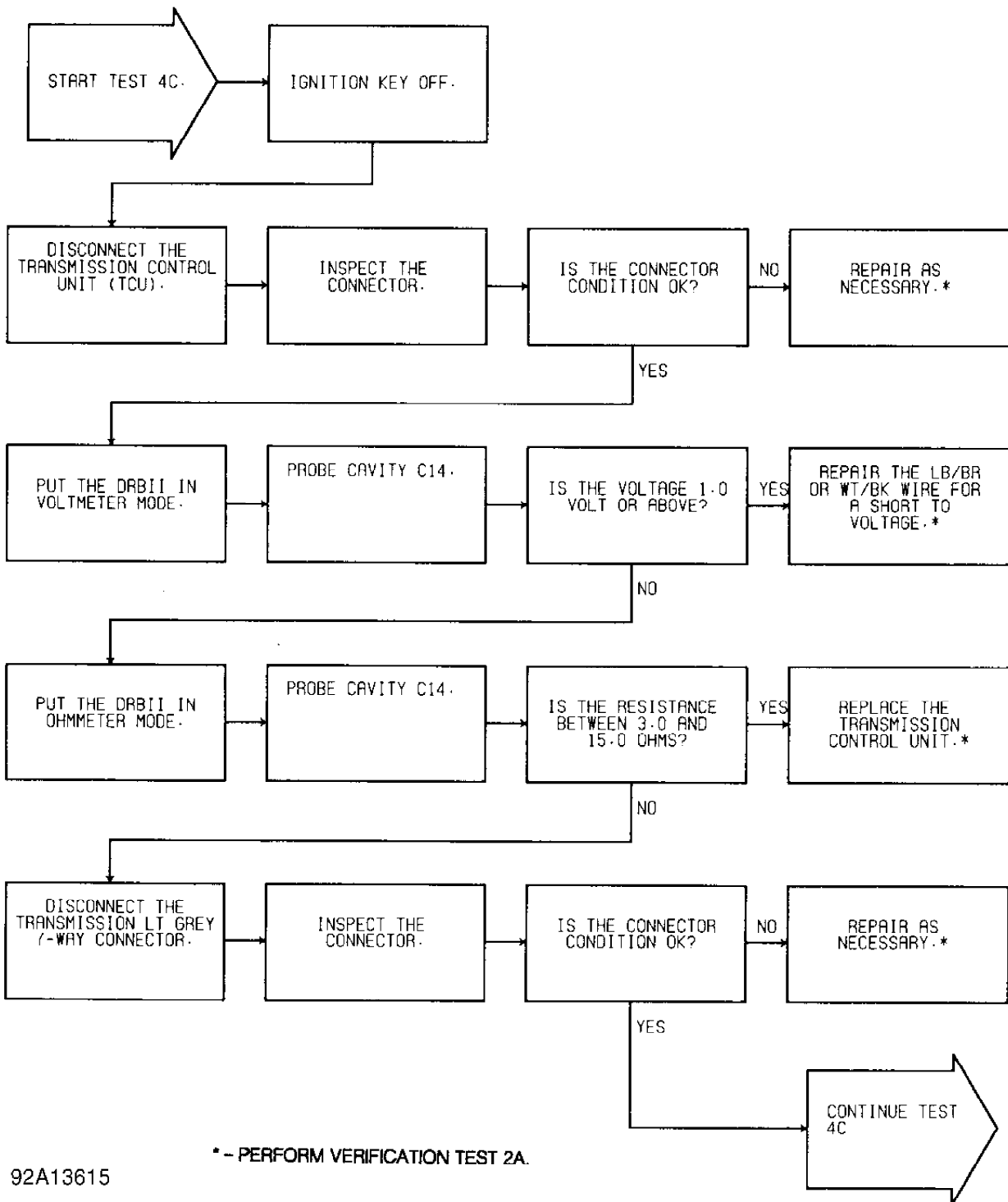


Fig. 31: Test 4B - Code 700, Testing S2 Control Wire

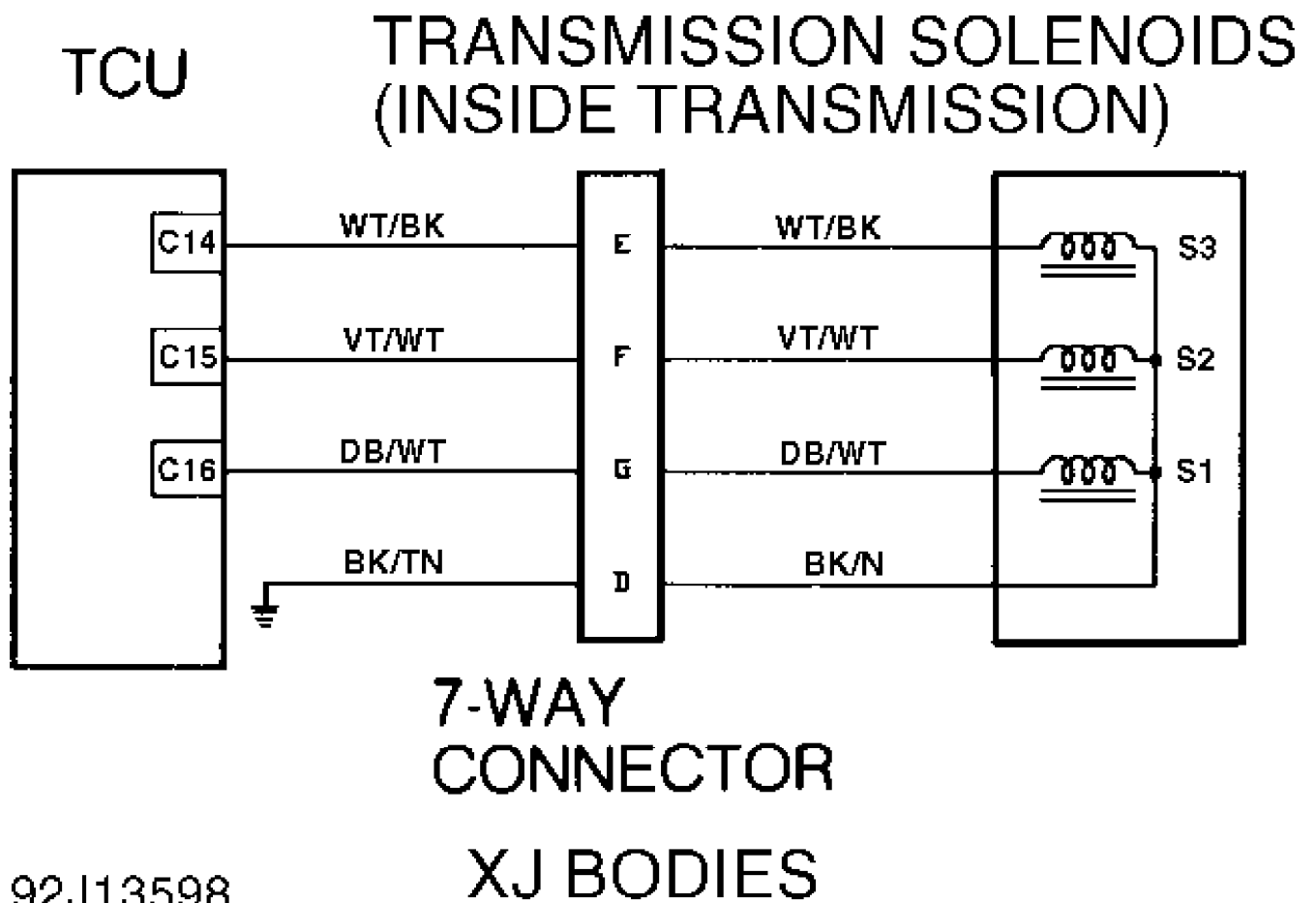
TEST 4C - CODE 700 - S3 SOLENOID CIRCUIT

Perform TEST 4A before proceeding.



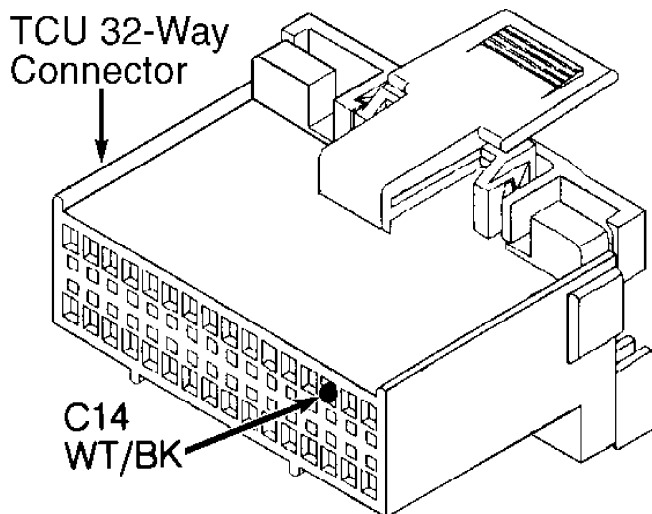
92A13615

Fig. 32: Test 4C - Code 700, Flow Chart (1 of 2)



92J13598

Fig. 33: Test 4C - Code 700, Schematic (Cherokee)



92B13616

**XJ BODY**

Fig. 34: Test 4C - TCU 32-Way Connector (Cavity 14, Cherokee)

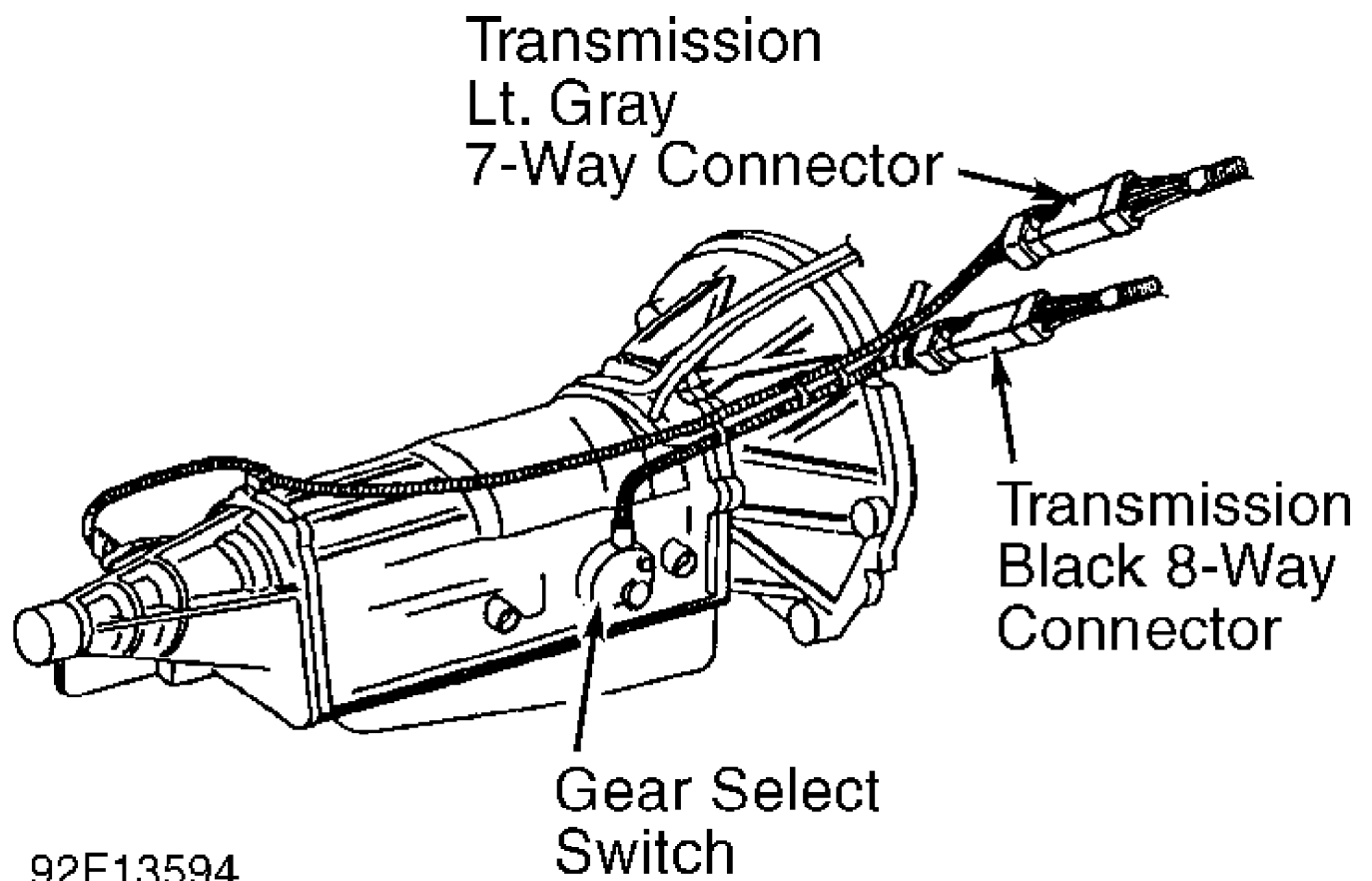
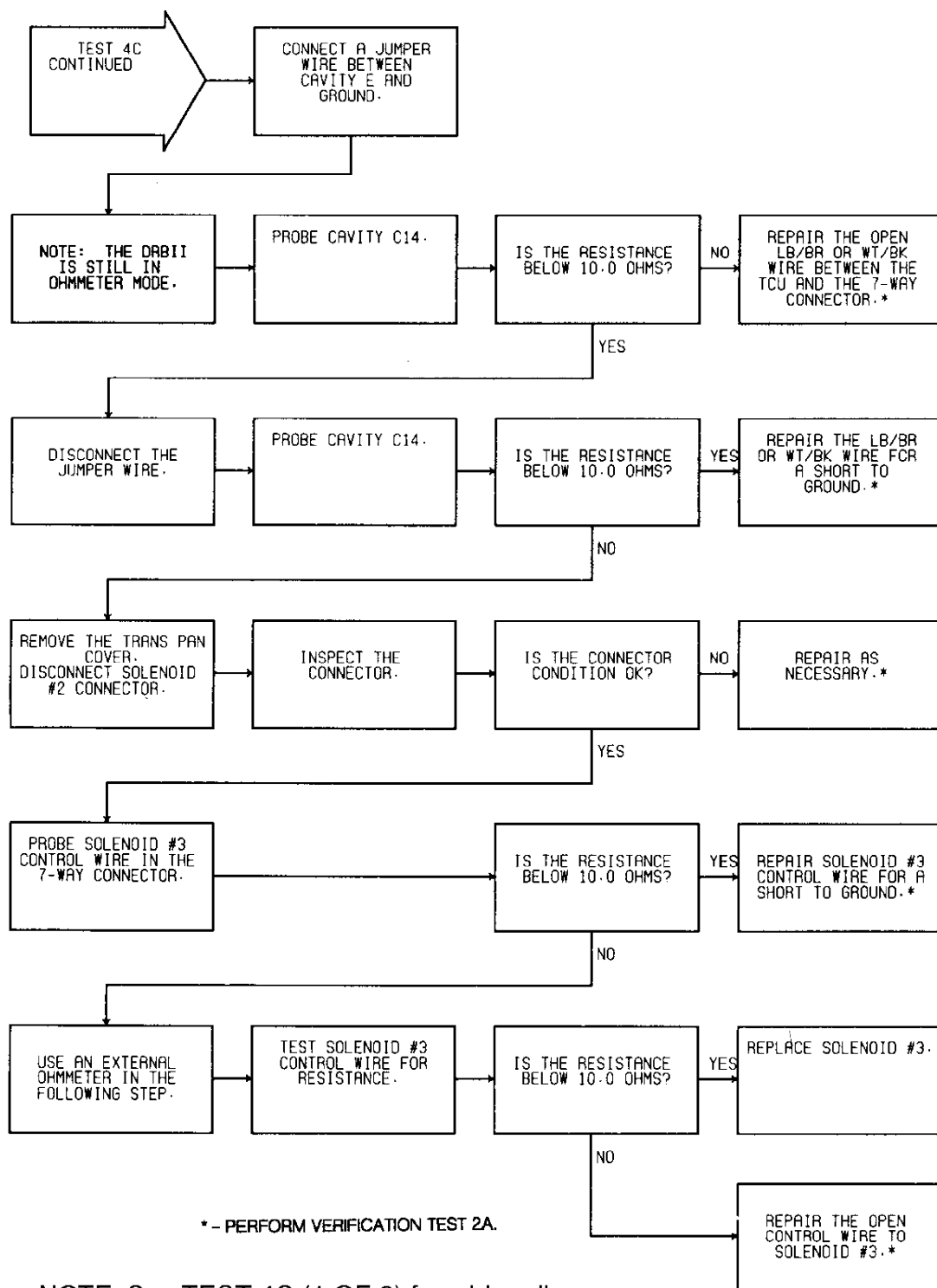
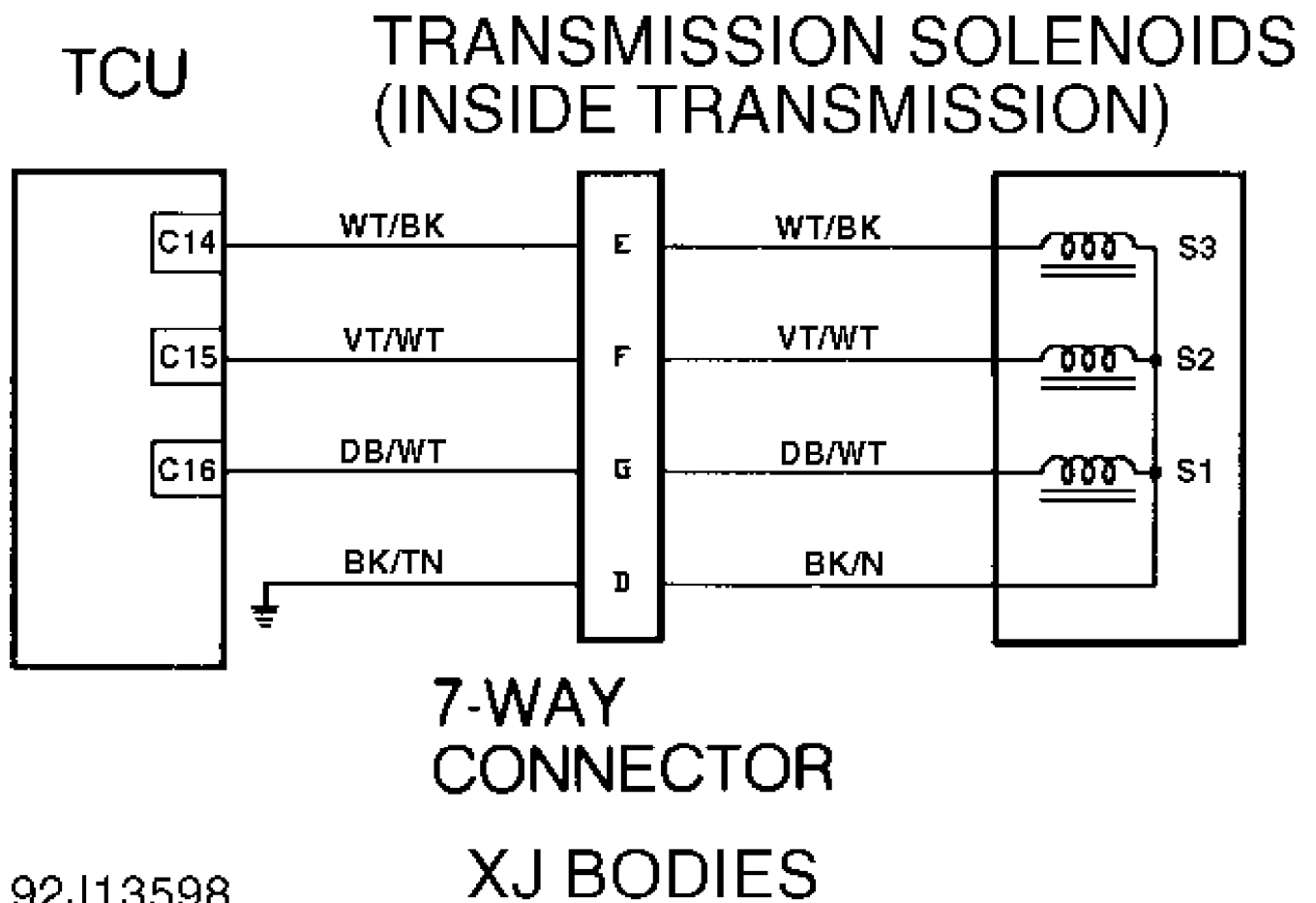


Fig. 35: Test 4C - Code 700, Location of 7-Way Connector



NOTE: See TEST 4C (1 OF 2) for wiring diagram.

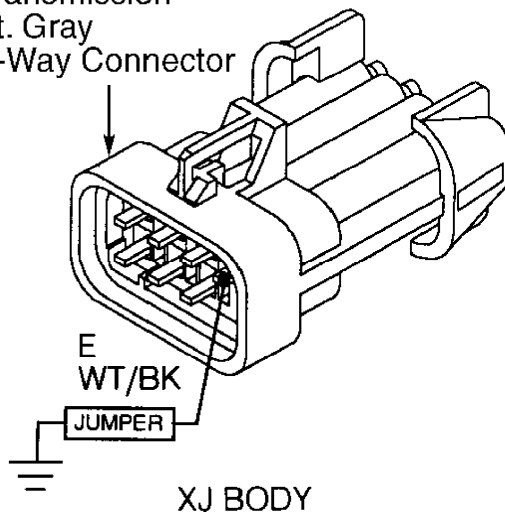
92D13618  
Fig. 36: Test 4C - Code 700, Flow Chart (2 of 2)



92J13598

Fig. 37: Test 4B - Code 700, Schematic (Cherokee)

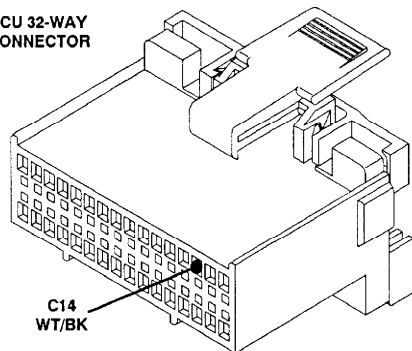
Transmission  
Lt. Gray  
7-Way Connector



92E13619

Fig. 38: Test 4C - 7-Way Connector Cavity "E" (Cherokee)

TCU 32-WAY  
CONNECTOR



C14  
WT/BK

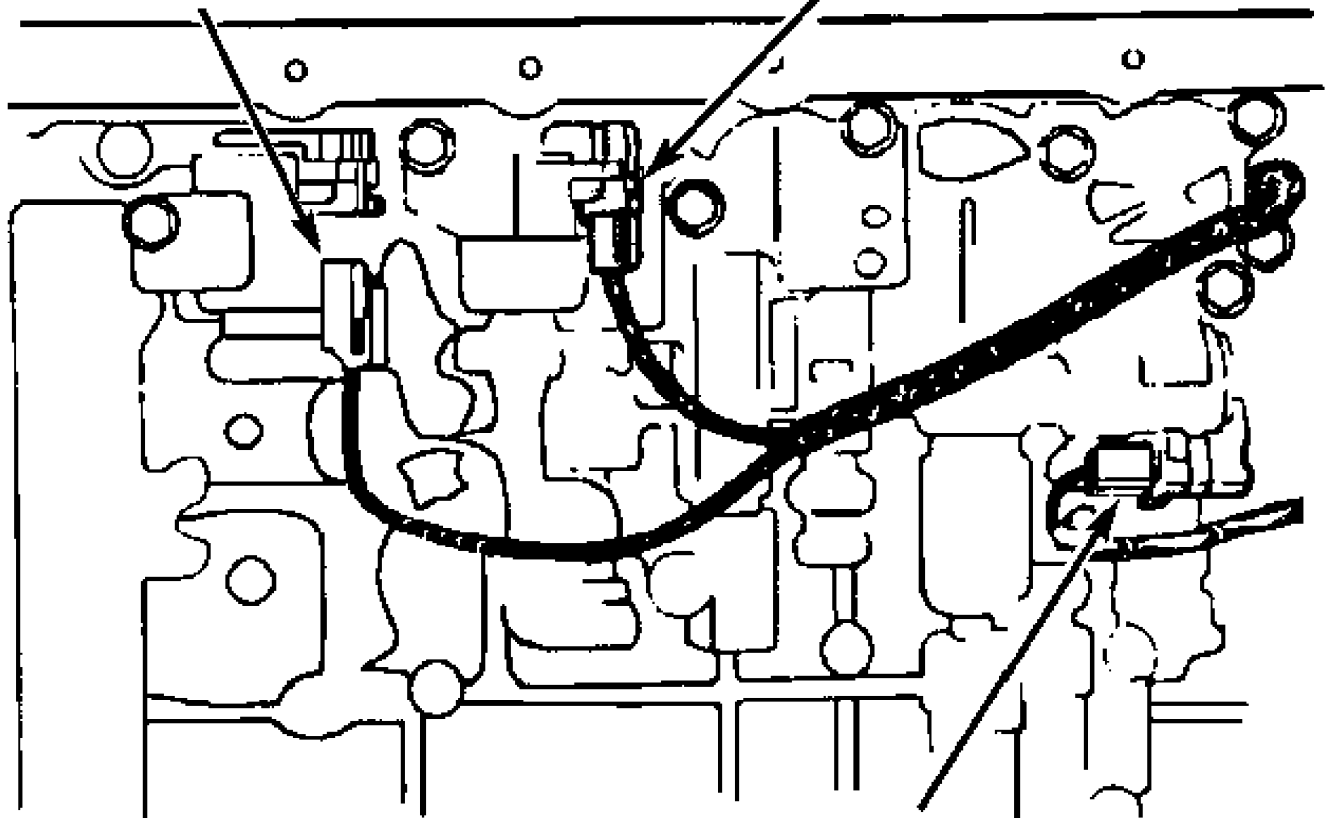
ZJ Body: LB/BR

92113621

Fig. 39: Test 4C - Code 700, TCU 32-Way Connector (Cavity 14)

Solenoid #3  
Connector

Solenoid #1  
Connector

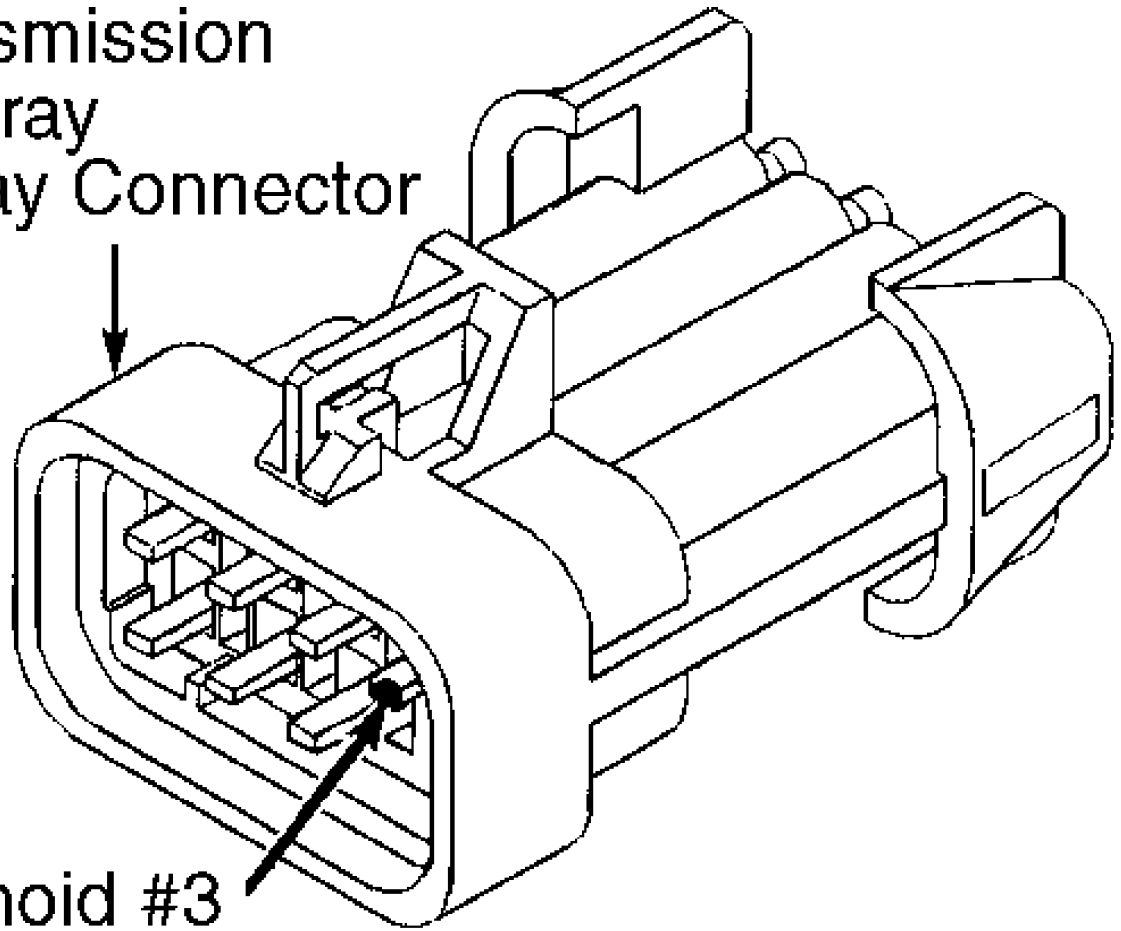


Solenoid #2  
Connector

92113605

Fig. 40: Test 4C - Code 700, Location of Solenoids

Transmission  
Lt. Gray  
7-Way Connector



Solenoid #3  
Connector

CAV	XJ	ZJ
E	WT/BK	LB/BR

92J13622

Fig. 41: Test 4C - Code 700, Solenoid No. 1 Wire (Cavity "E")

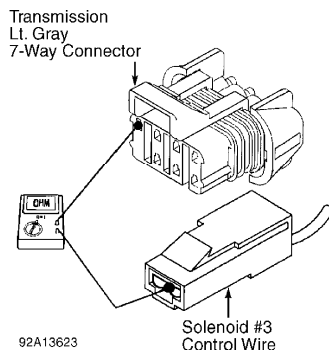


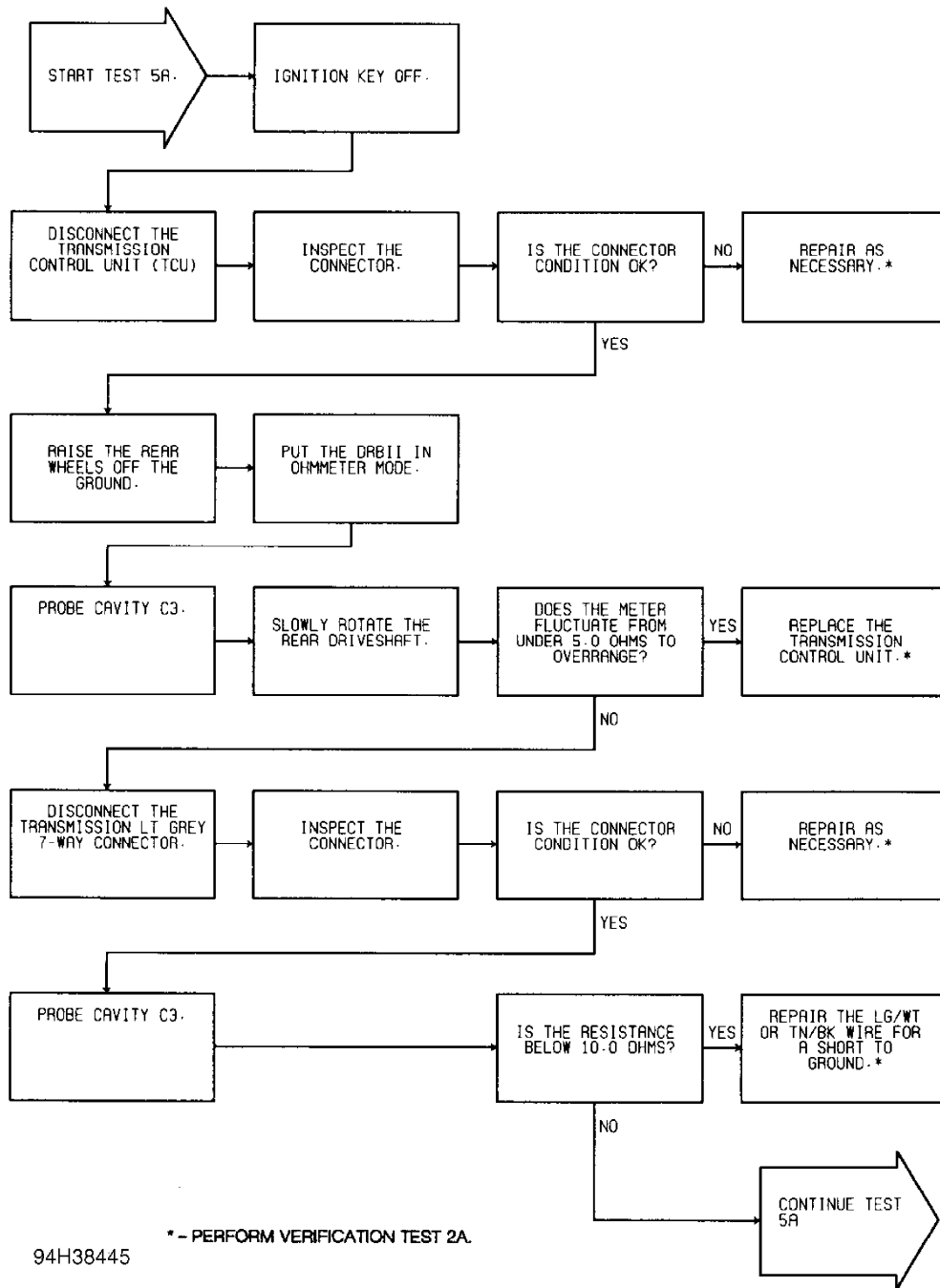
Fig. 42: Test 4C - Code 700, Testing S3 Control Wire



## TEST 5A - CODE 702 - SPEED SENSOR CIRCUIT

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

Perform TEST 1A before proceeding.



94H38445

Fig. 43: Test 5A - Code 702, Flow Chart (1 of 2)

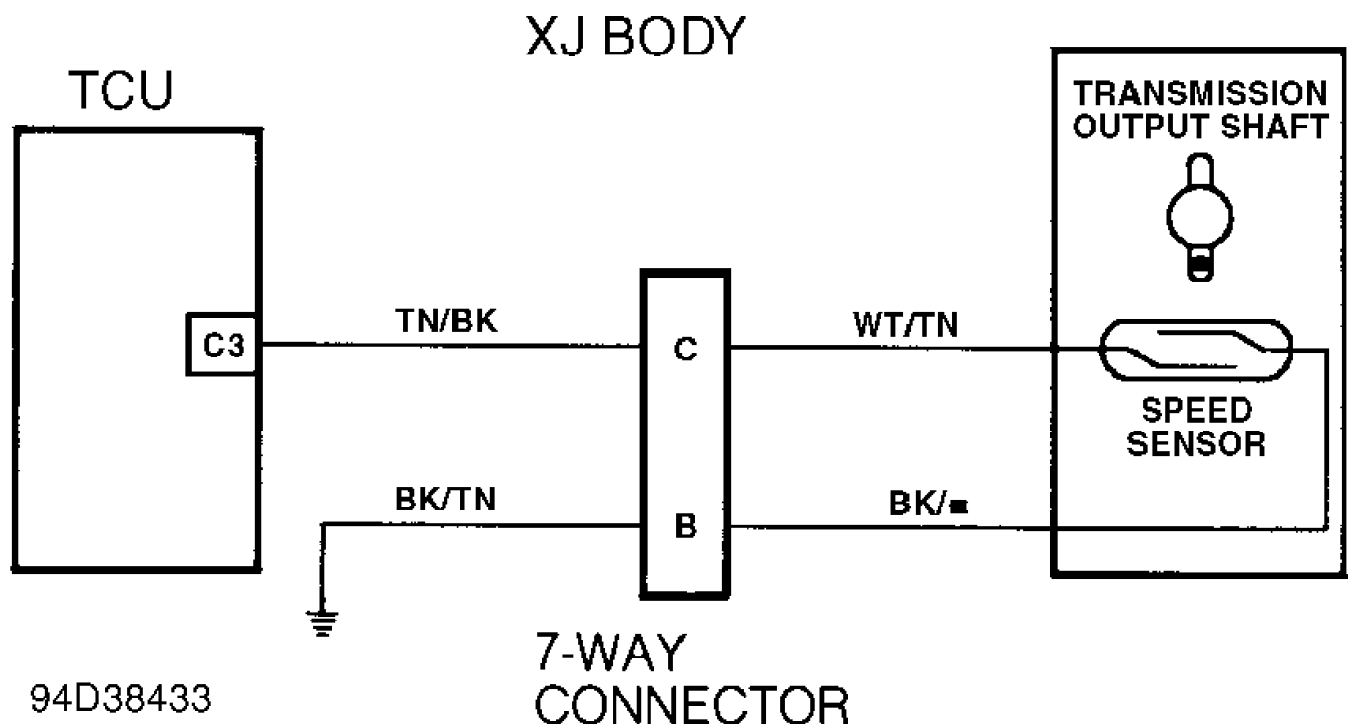


Fig. 44: Test 5A - Code 702, Speed Sensor Schematic (Cherokee)

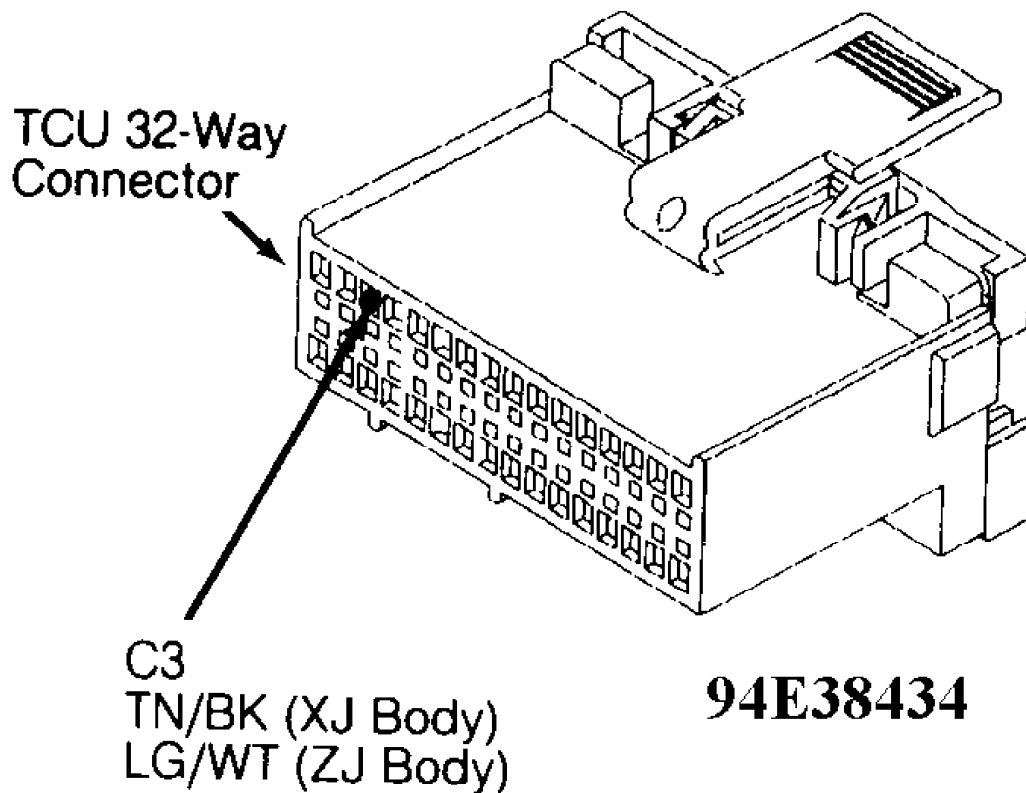
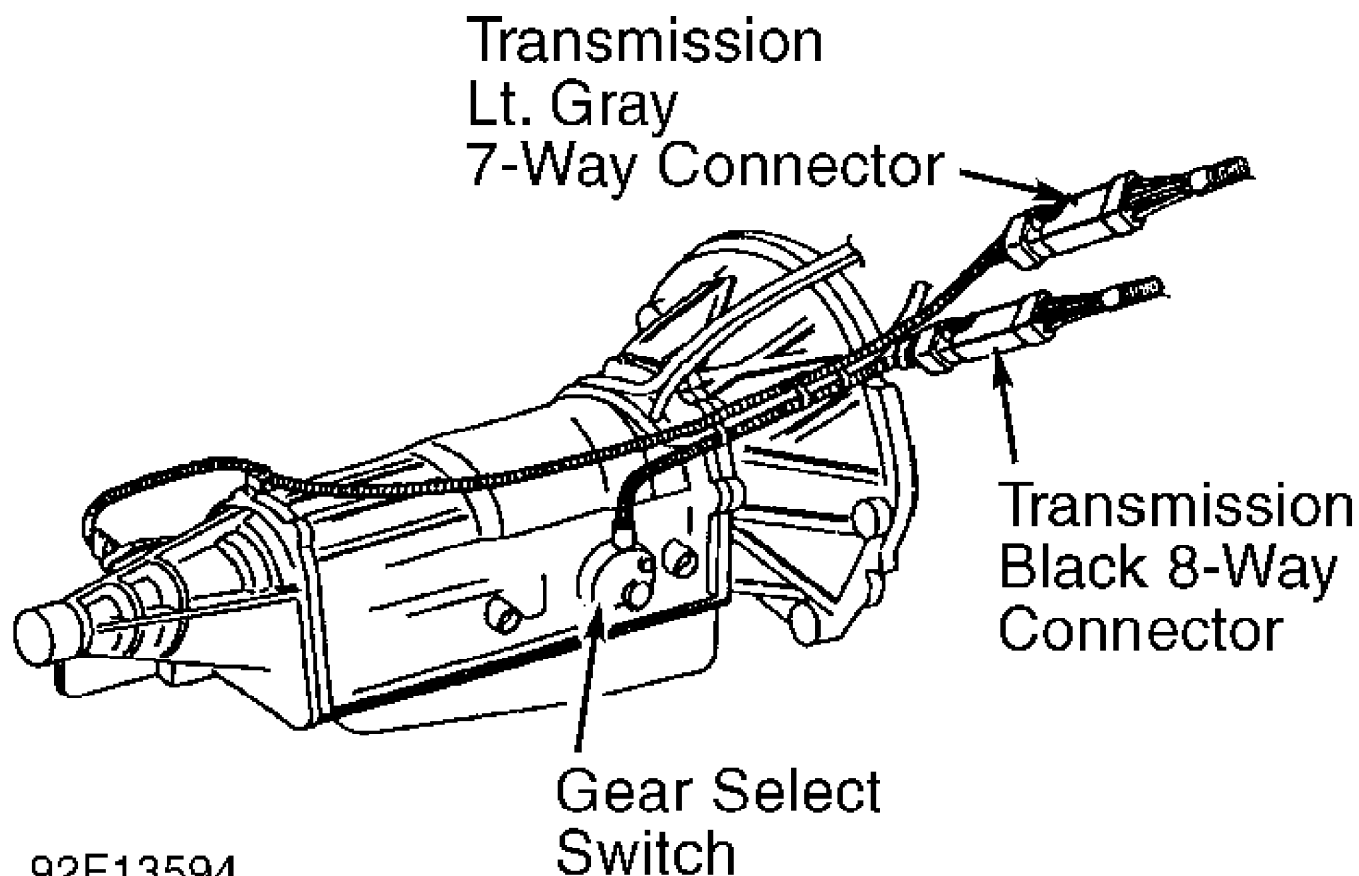
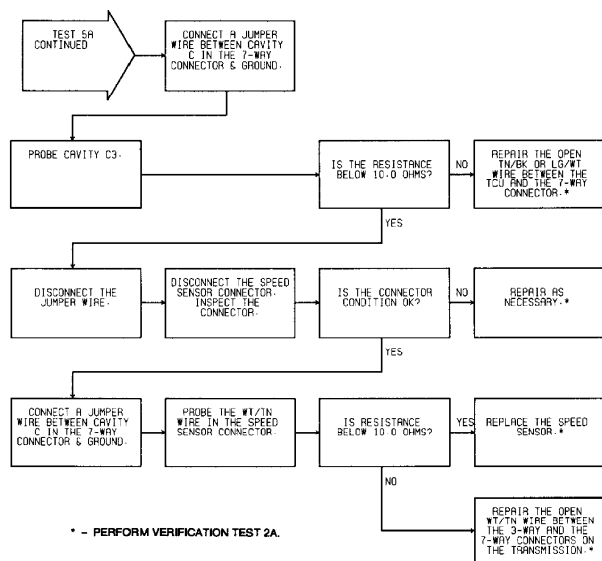


Fig. 45: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)



92F13594

Fig. 46: Test 5A - Code 702, Location of 7-Way Connector



NOTE: See TEST 5A (1 OF 2) for wiring diagram.

94F38435

Fig. 47: Test 5A - Code 702, Flow Chart (2 of 2)

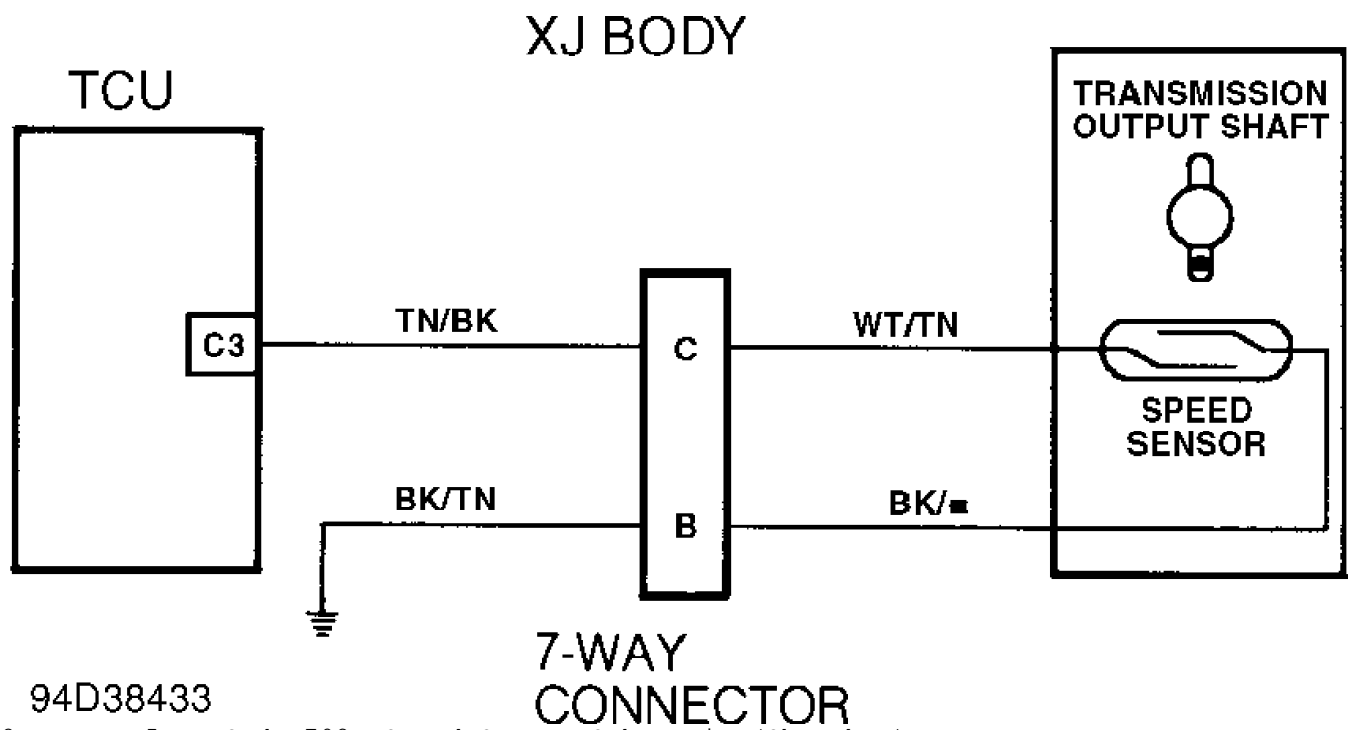


Fig. 48: Test 5A - Code 702, Speed Sensor Schematic (Cherokee)

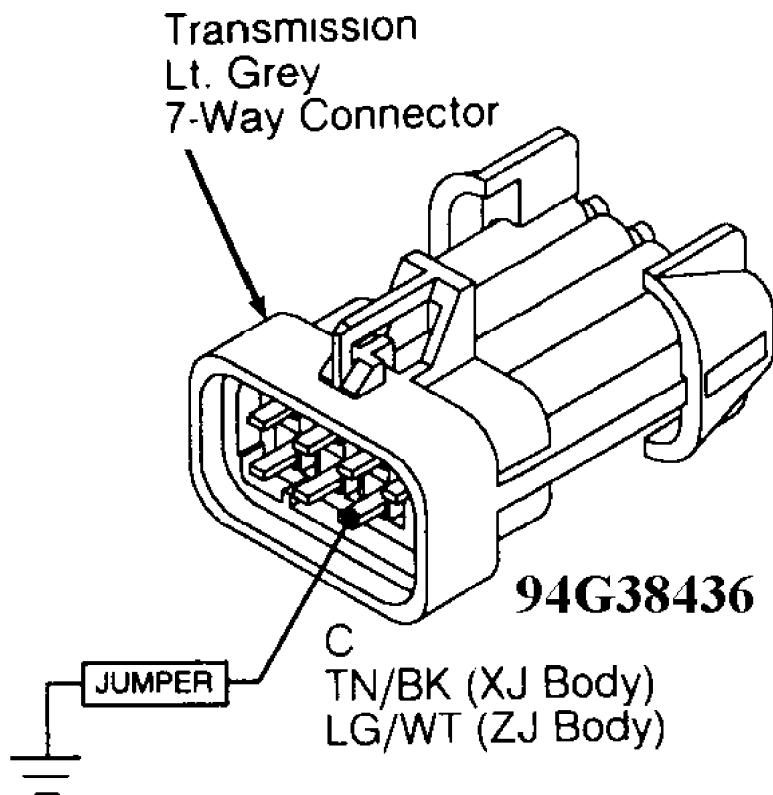


Fig. 49: Test 5A - Transmission 7-Way Connector (Male Side)

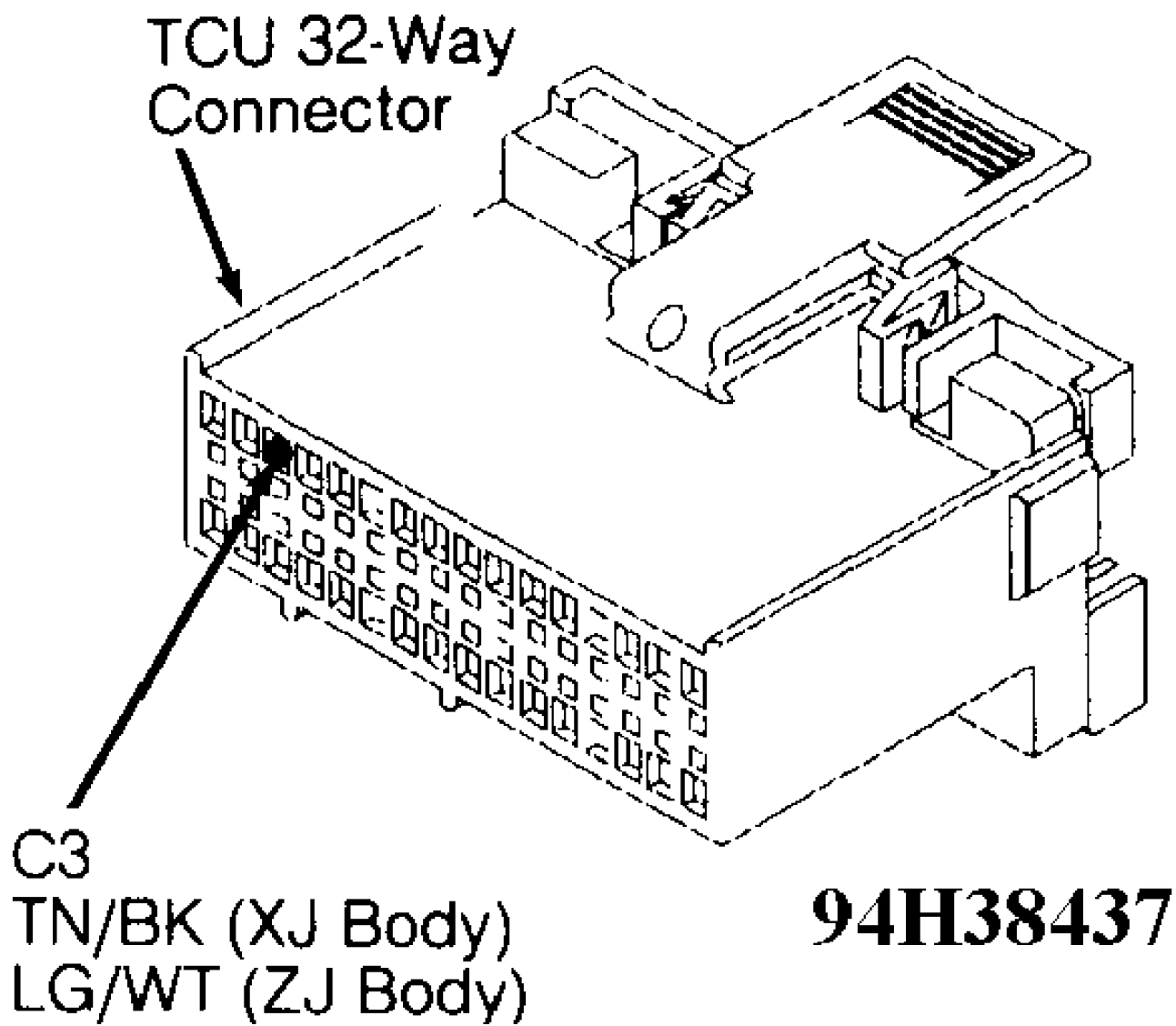


Fig. 50: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)

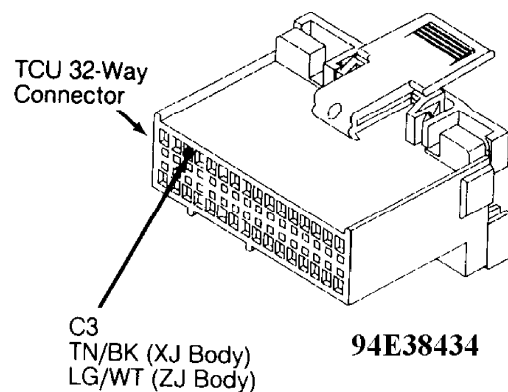
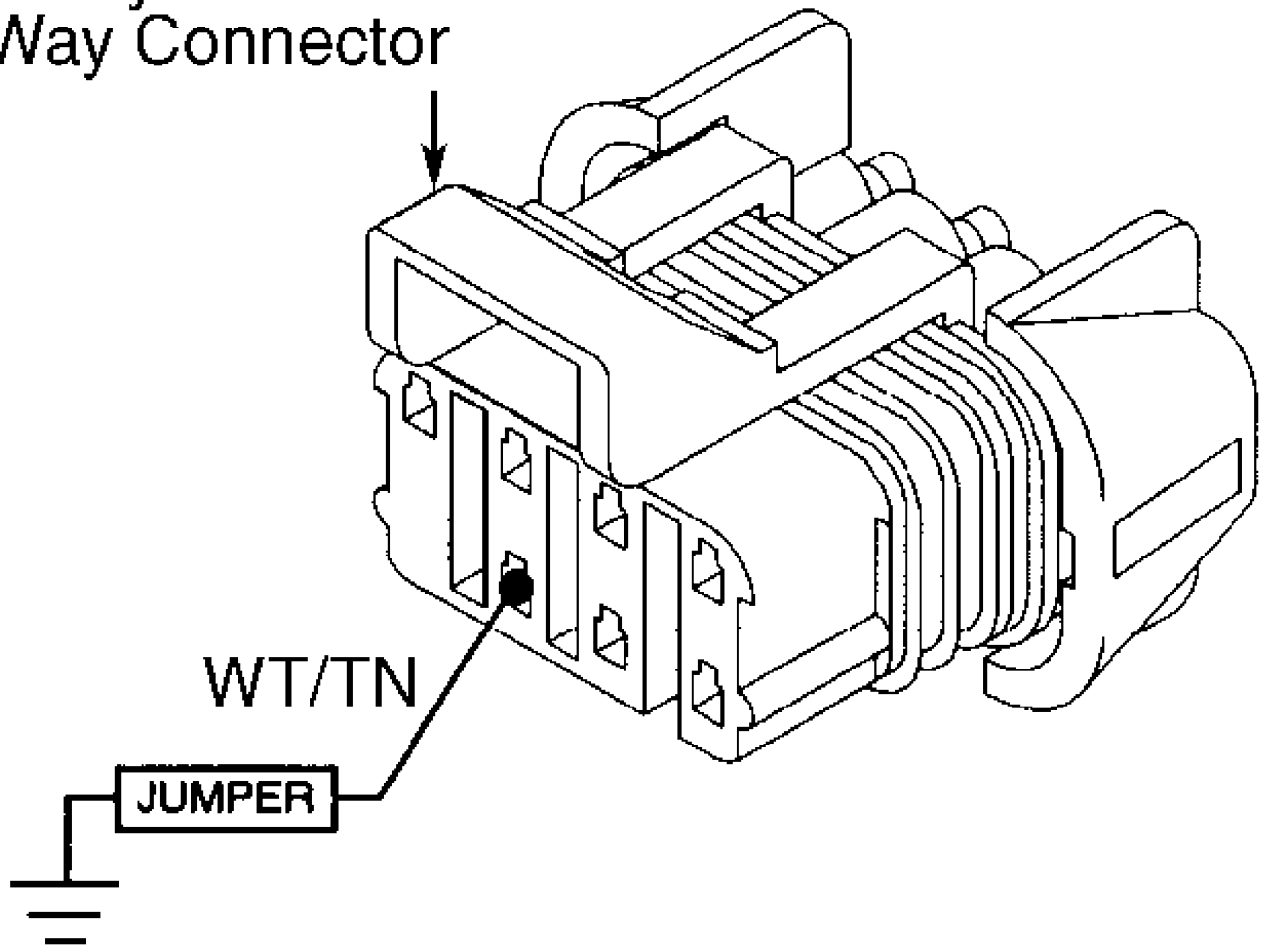


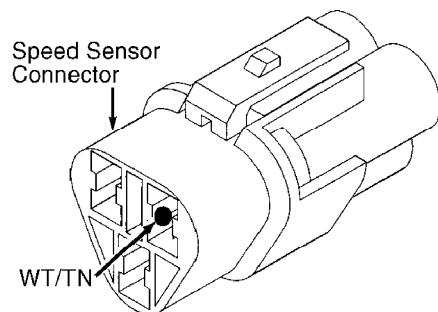
Fig. 51: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)

# Transmission Lt. Gray 7-Way Connector



92H14255

Fig. 52: Test 5A - Transmission 7-Way Connector (Female Side)

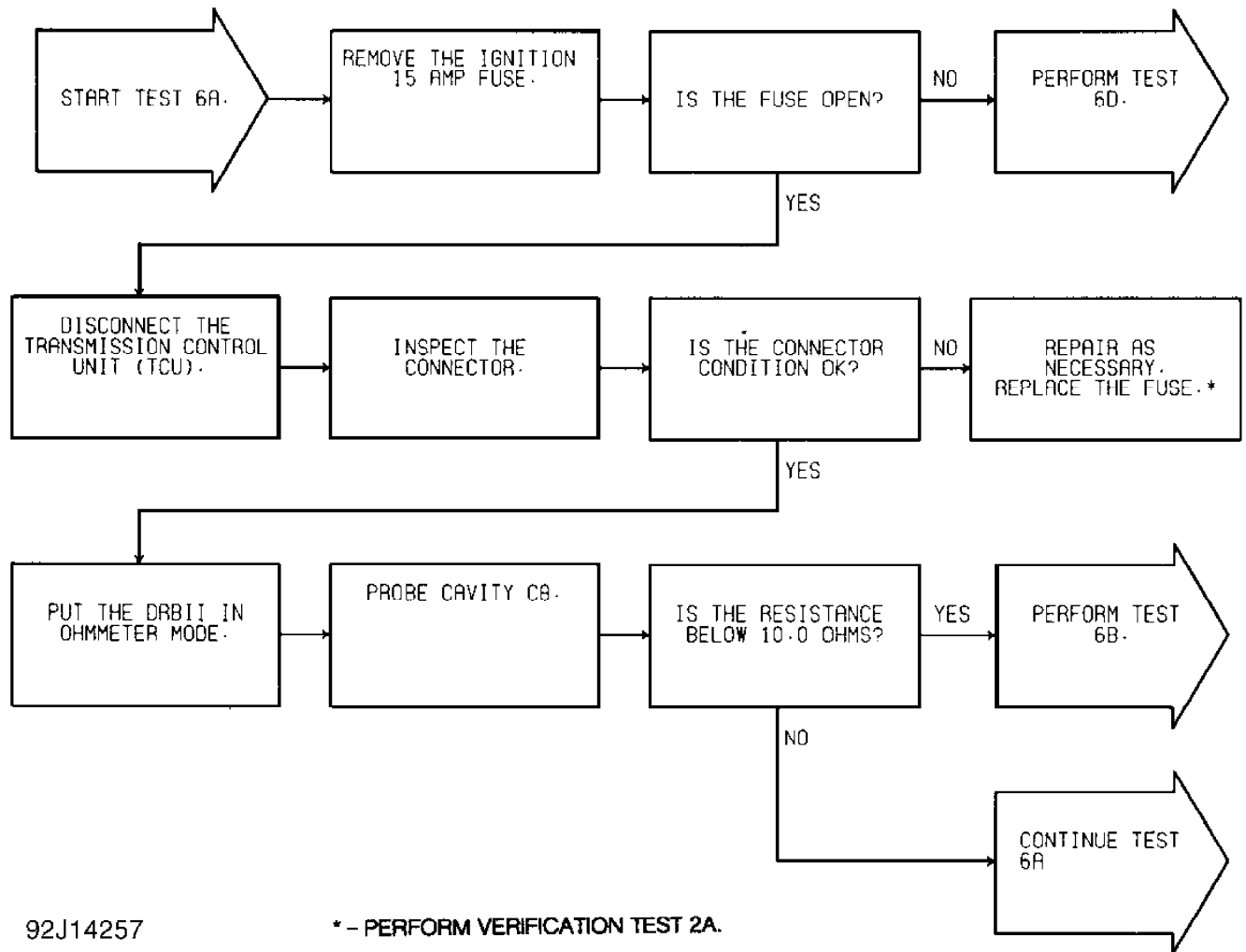


92H14256

Fig. 53: Test 5A - Code 702, View of Speed Sensor Connector

TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT

Perform TEST 1A before proceeding.

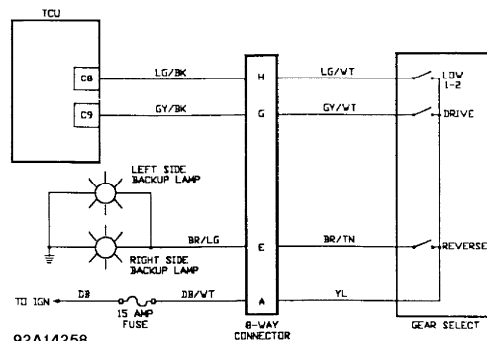


92J14257

\* - PERFORM VERIFICATION TEST 2A.

Fig. 54: Test 6A - Code 703, Flow Chart (1 of 2)

MJ and XJ Bodies



92A14258

Fig. 55: Test 6A - Gear Select Switch Schematic (Cherokee)

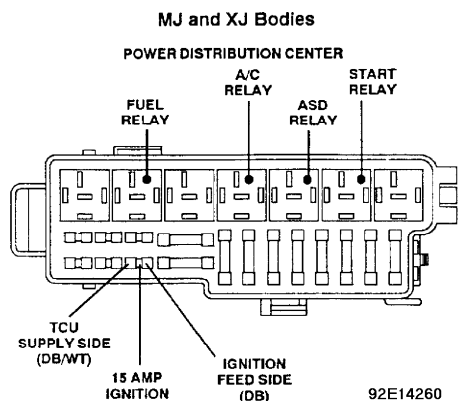
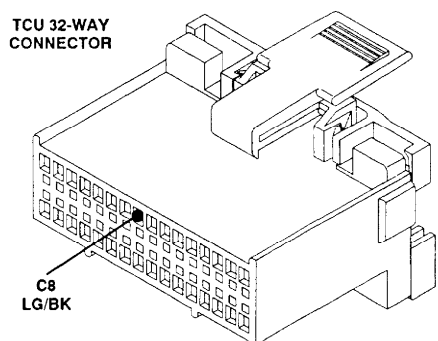
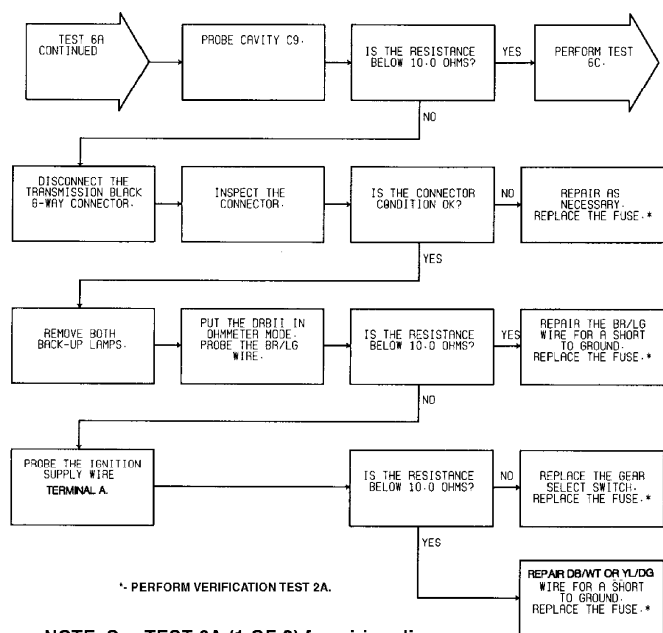


Fig. 56: Test 6A - Location of Gear Select Switch Fuse (Cherokee)



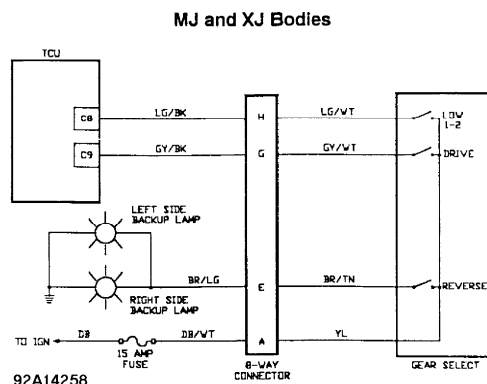
**ZJ Body: LG** 92G14262  
Fig. 57: Test 6A - TCU 32-Way Connector (Cavity 8)



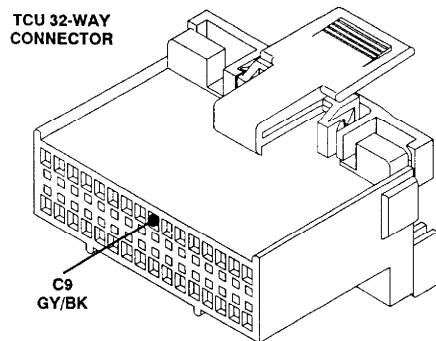
NOTE: See TEST 6A (1 OF 2) for wiring diagram.

92H14263  
Fig. 58: Test 6A - Code 703, Flow Chart (2 of 2)

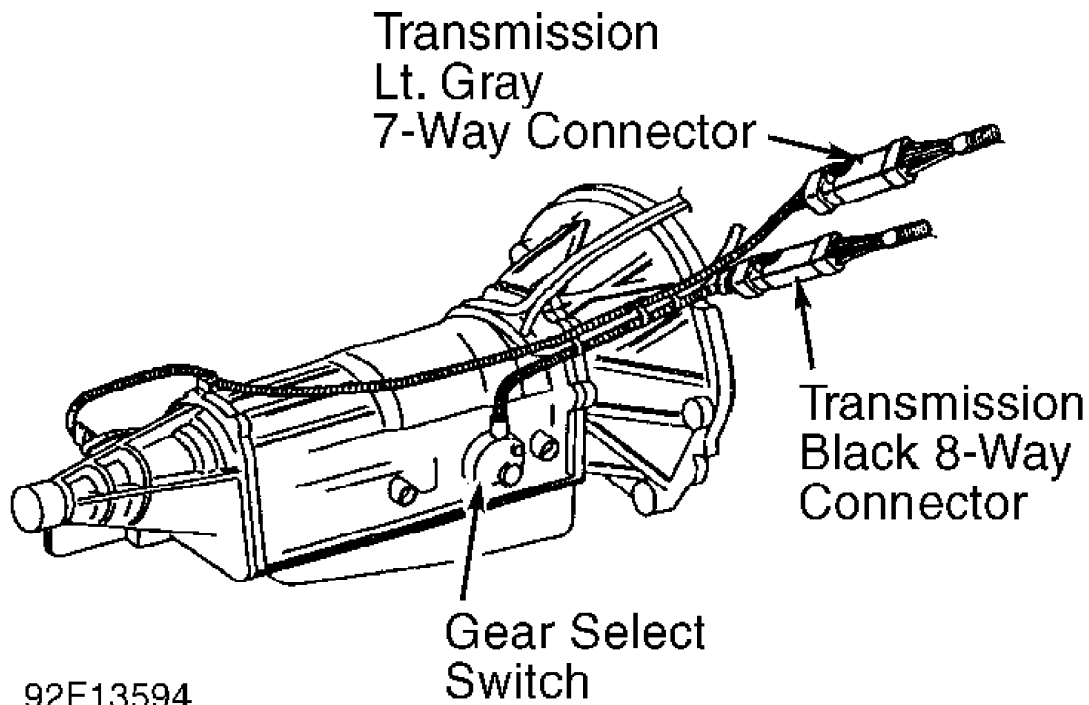




92A14258  
Fig. 59: Test 6A - Gear Select Switch Schematic (Cherokee)

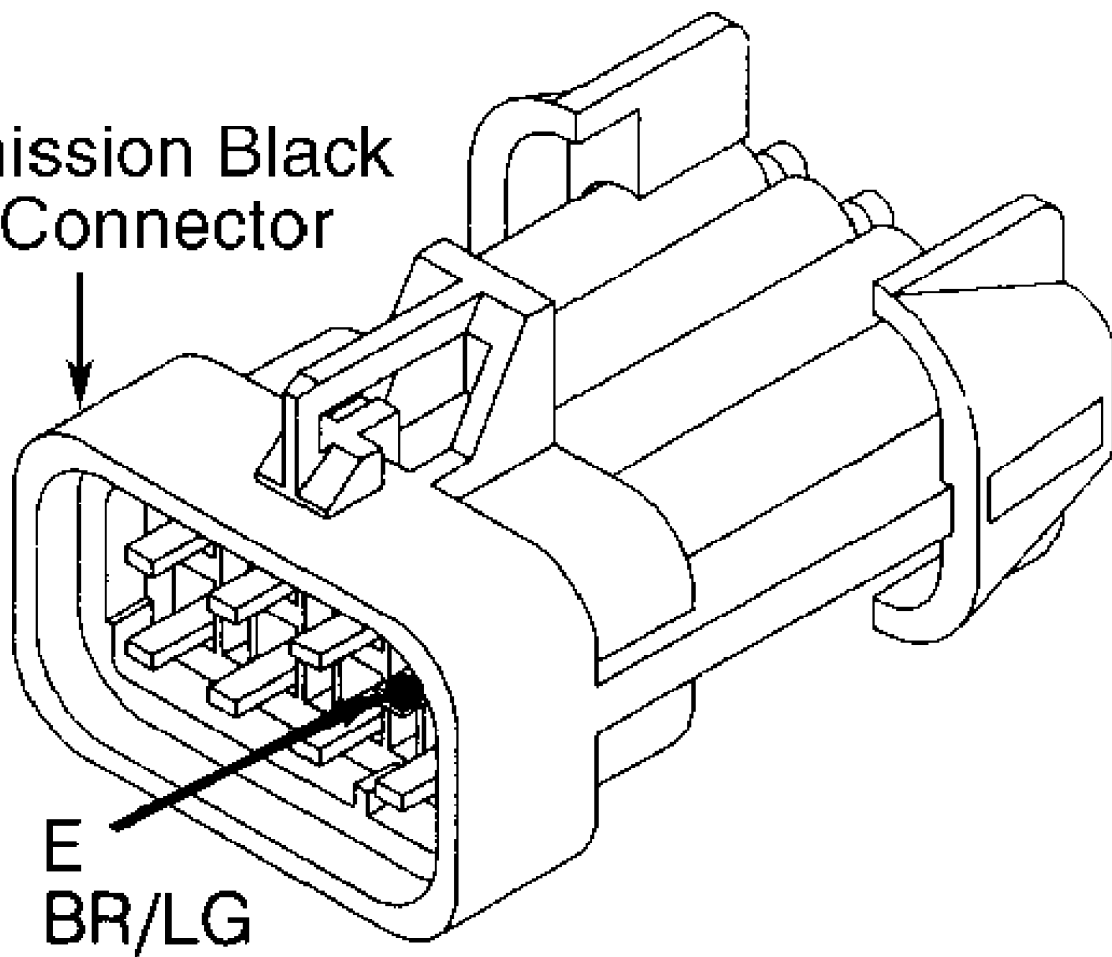


ZJ Body: DG  
92I14264  
Fig. 60: Test 6A - Code 703, TCU 32-Way Connector (Cavity 9)



92F13594  
Fig. 61: Test 6A - Code 703, Location of Gear Select Switch

## Transmission Black 8-Way Connector

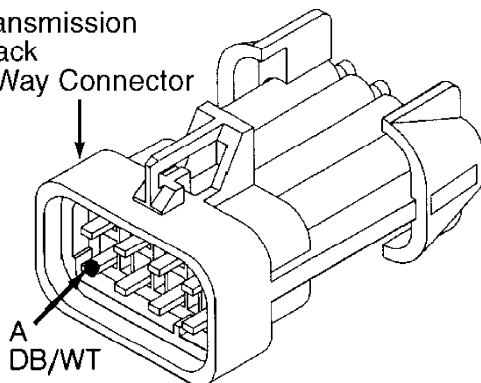


92J14265

Fig. 62: Test 6A - Code 703, 8-Way Black Connector Cavity "E"

XJ BODY

## Transmission Black 8-Way Connector



92A14266

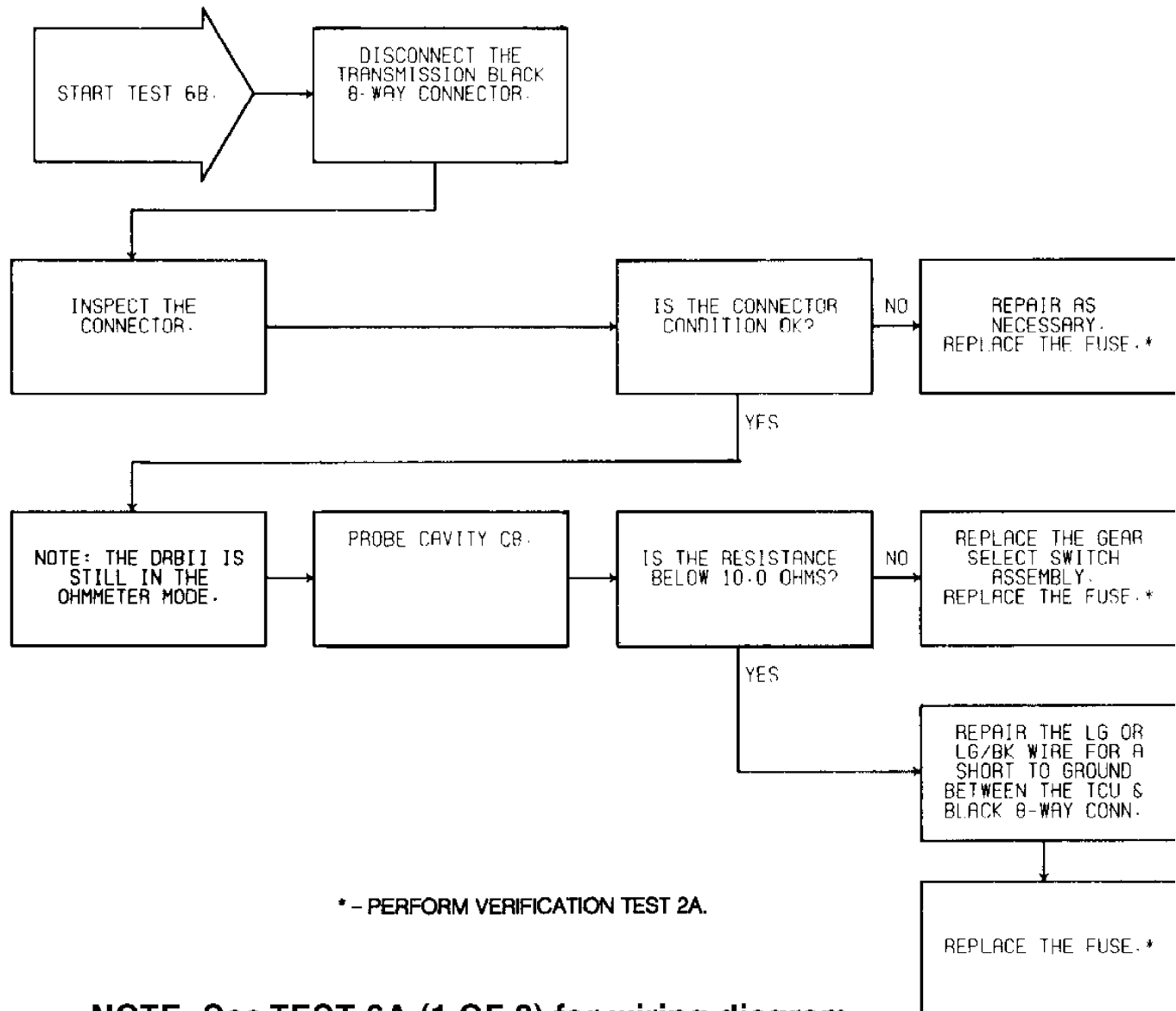
Fig. 63: Test 6A - 8-Way Black Connector Cavity "A" (Cherokee)

## TEST 6B - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT

before proceeding.

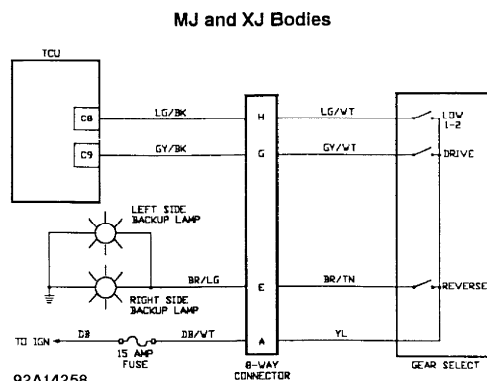
**Perform TEST 6A before proceeding.**



**NOTE: See TEST 6A (1 OF 2) for wiring diagram.**

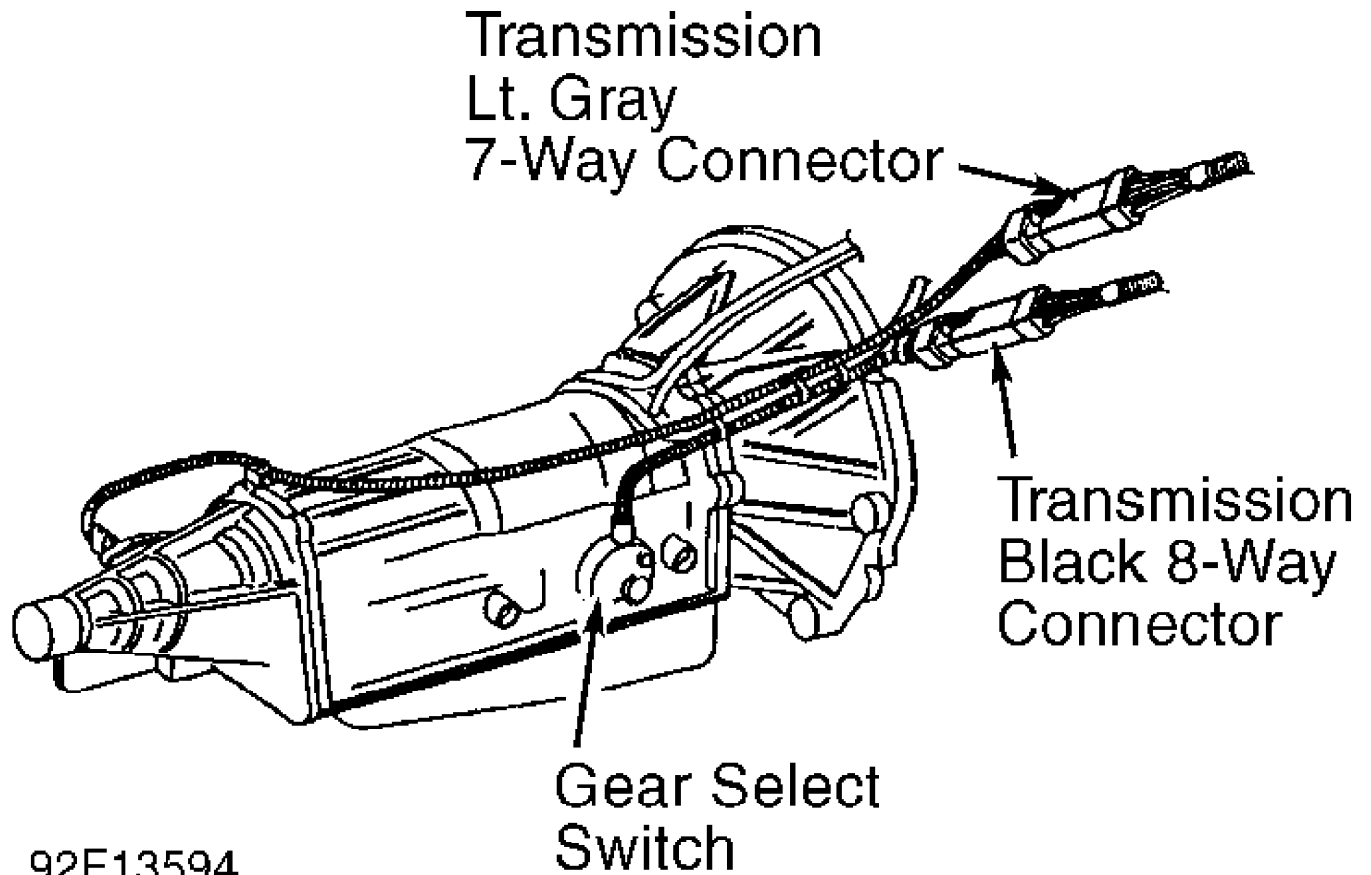
92C14268

Fig. 64: Test 6B - Code 703, Flow Chart



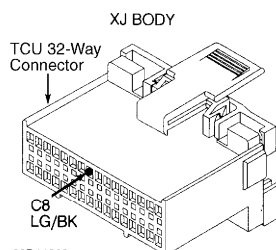
92A14258

Fig. 65: Test 6B - Gear Select Switch Schematic (Cherokee)



**92F13594**

Fig. 66: Test 6B - Code 703, Location of Gear Select Switch



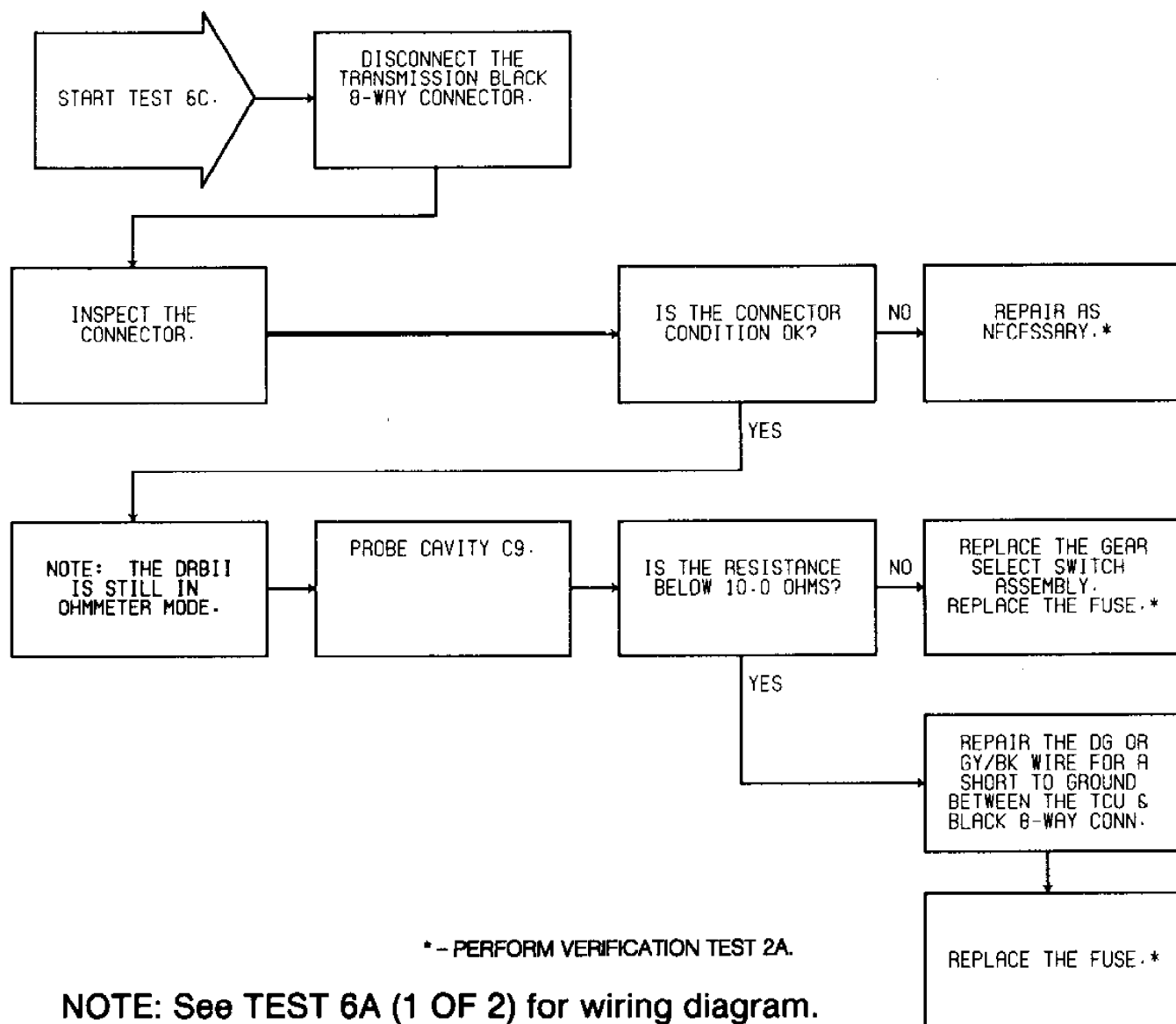
92D14269

Fig. 67: Test 6B - TCU 32-Way Connector (Cavity 8, Cherokee)

**TEST 6C - CODE 703 - GEAR SELECT SWITCH CIRCUIT**

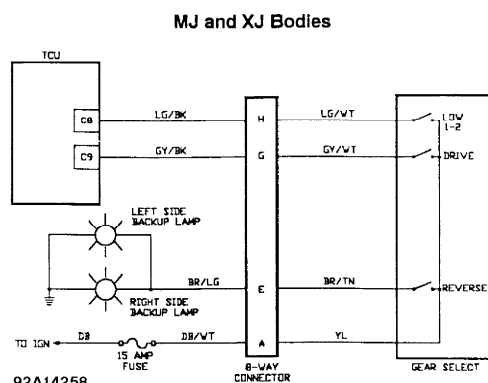
NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

**Perform TEST 6A before proceeding.**



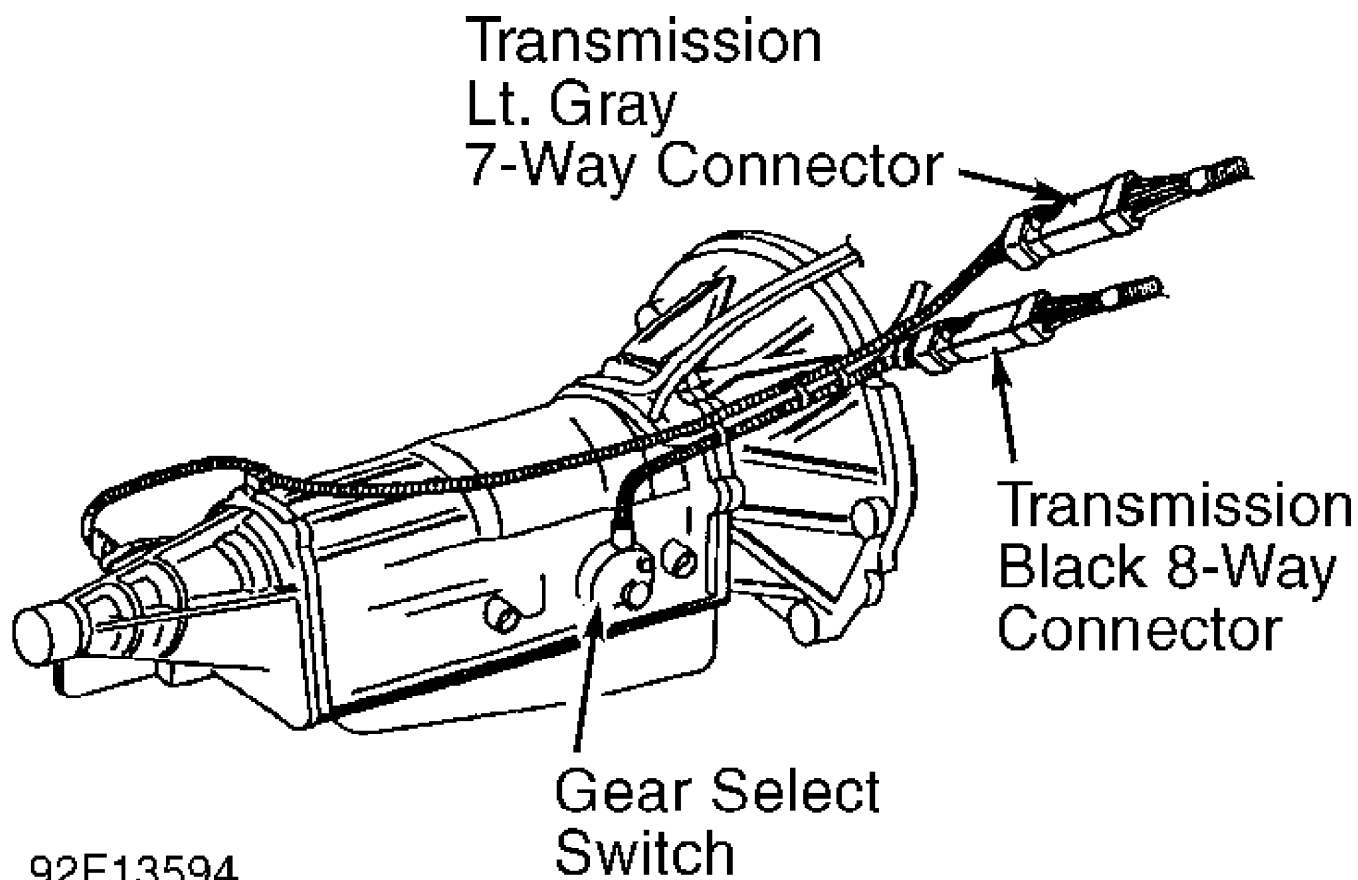
92H14271

Fig. 68: Test 6C - Code 703, Flow Chart



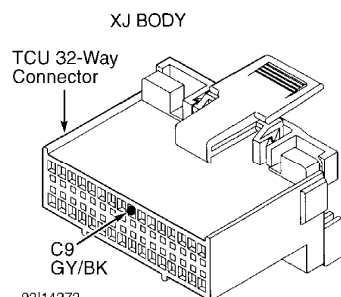
92A14258

Fig. 69: Test 6C - Gear Select Switch Schematic (Cherokee)



92F13594

Fig. 70: Test 6C - Code 703, Location of Gear Select Switch



92114272

Fig. 71: Test 6C - TCU 32-Way Connector (Cavity 9, Cherokee)

## TEST 6D - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

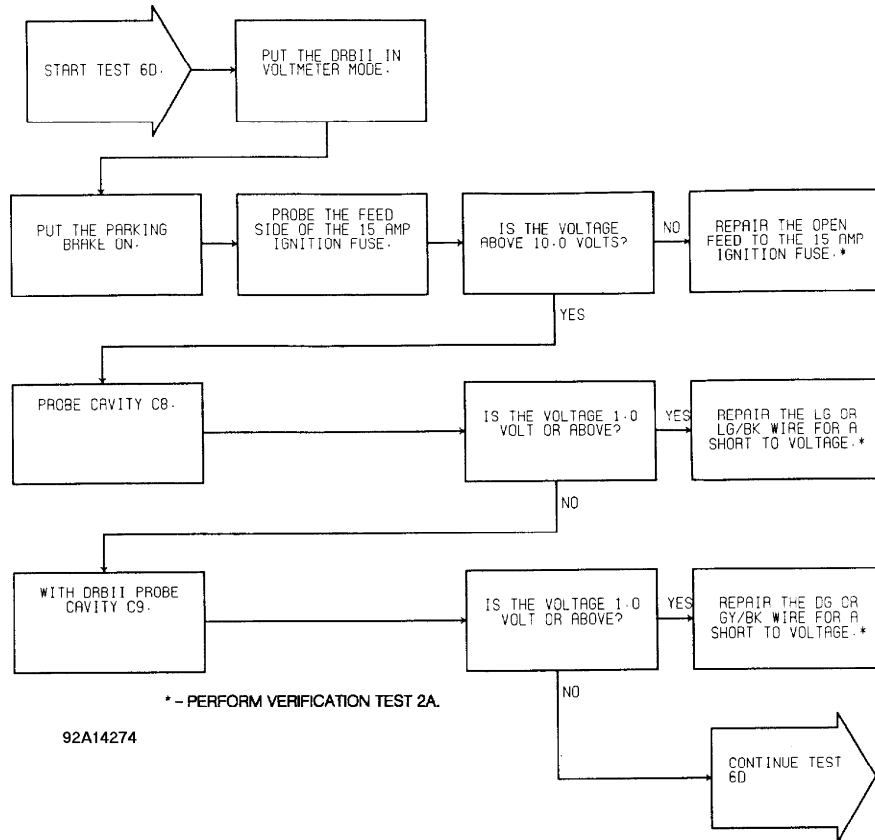


Fig. 72: Test 6D - Code 703, Flow Chart (1 of 3)

### MJ and XJ Bodies

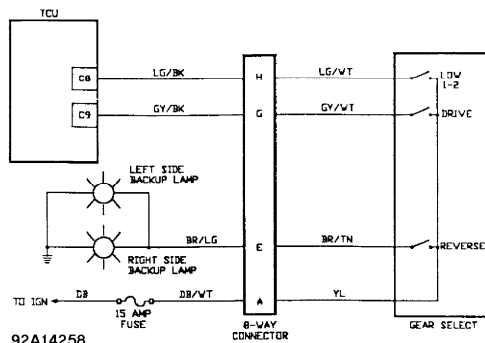


Fig. 73: Test 6D - Gear Select Switch Schematic (Cherokee)

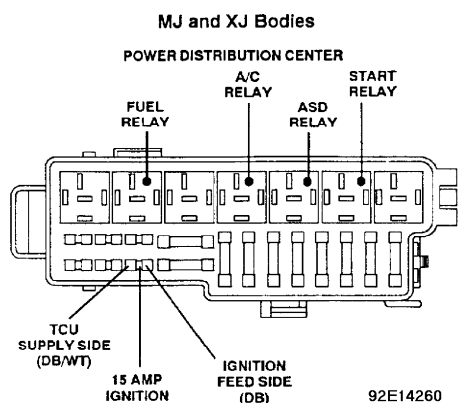


Fig. 74: Test 6D - Location of Gear Select Switch Fuse (Cherokee)

## XJ BODY

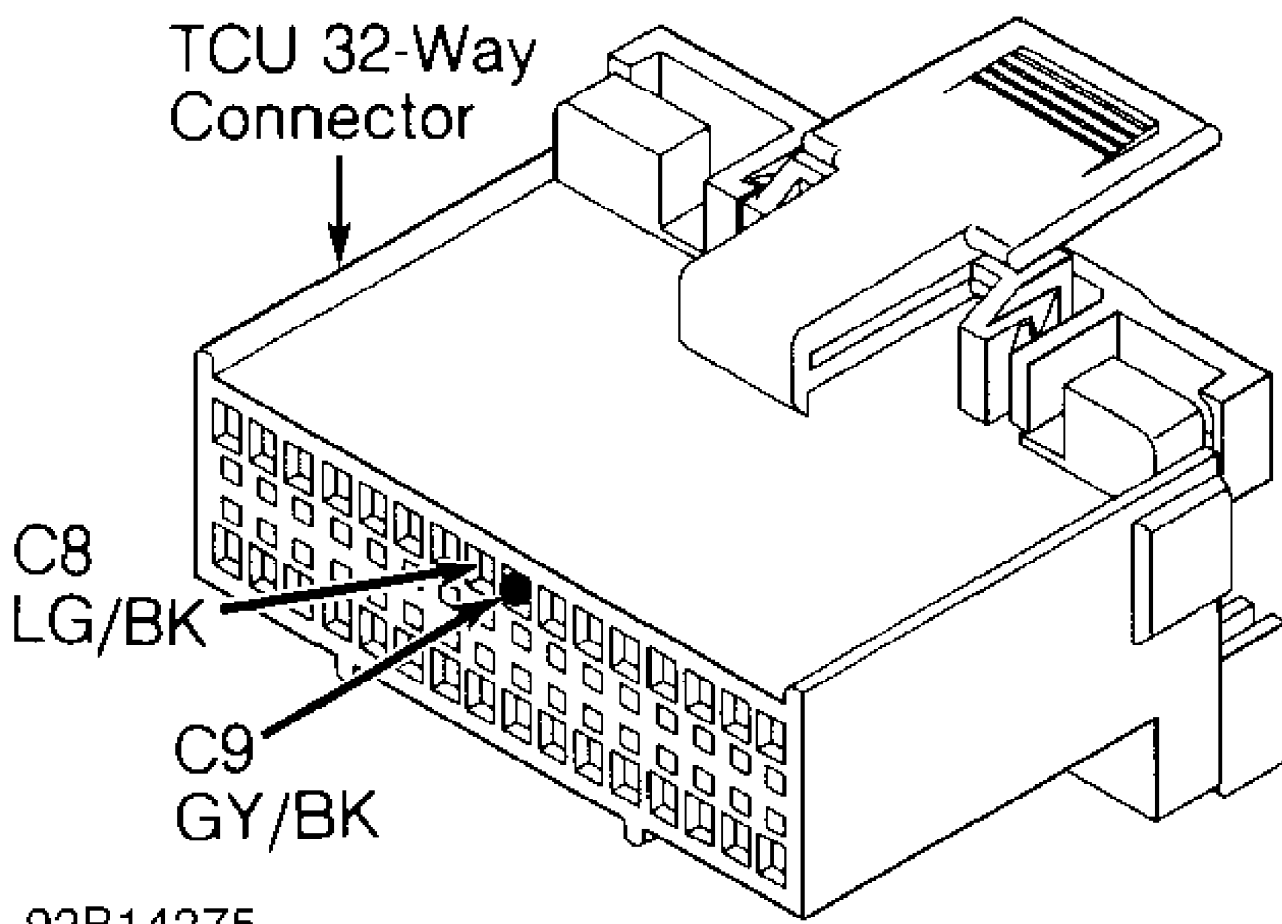
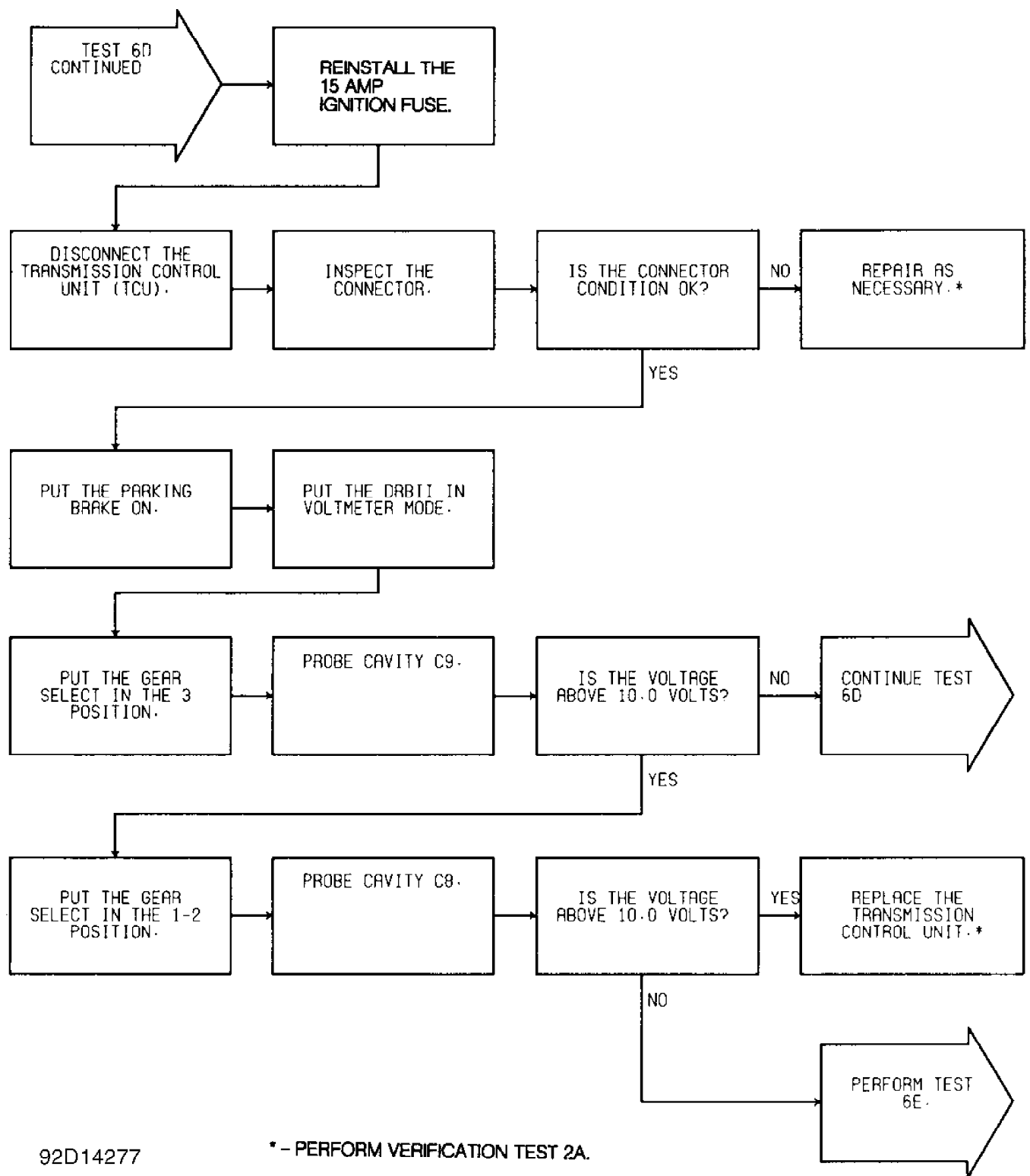


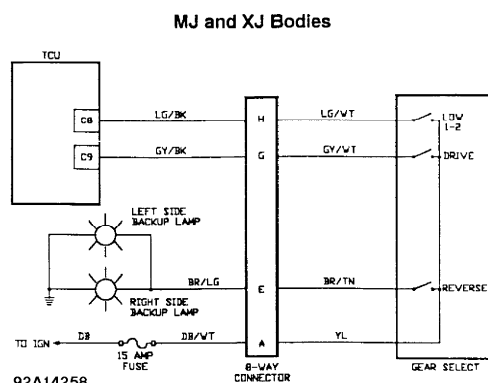
Fig. 75: Test 6D - TCU 32-Way Connector (Cavities 8 & 9, Cherokee)





92D14277

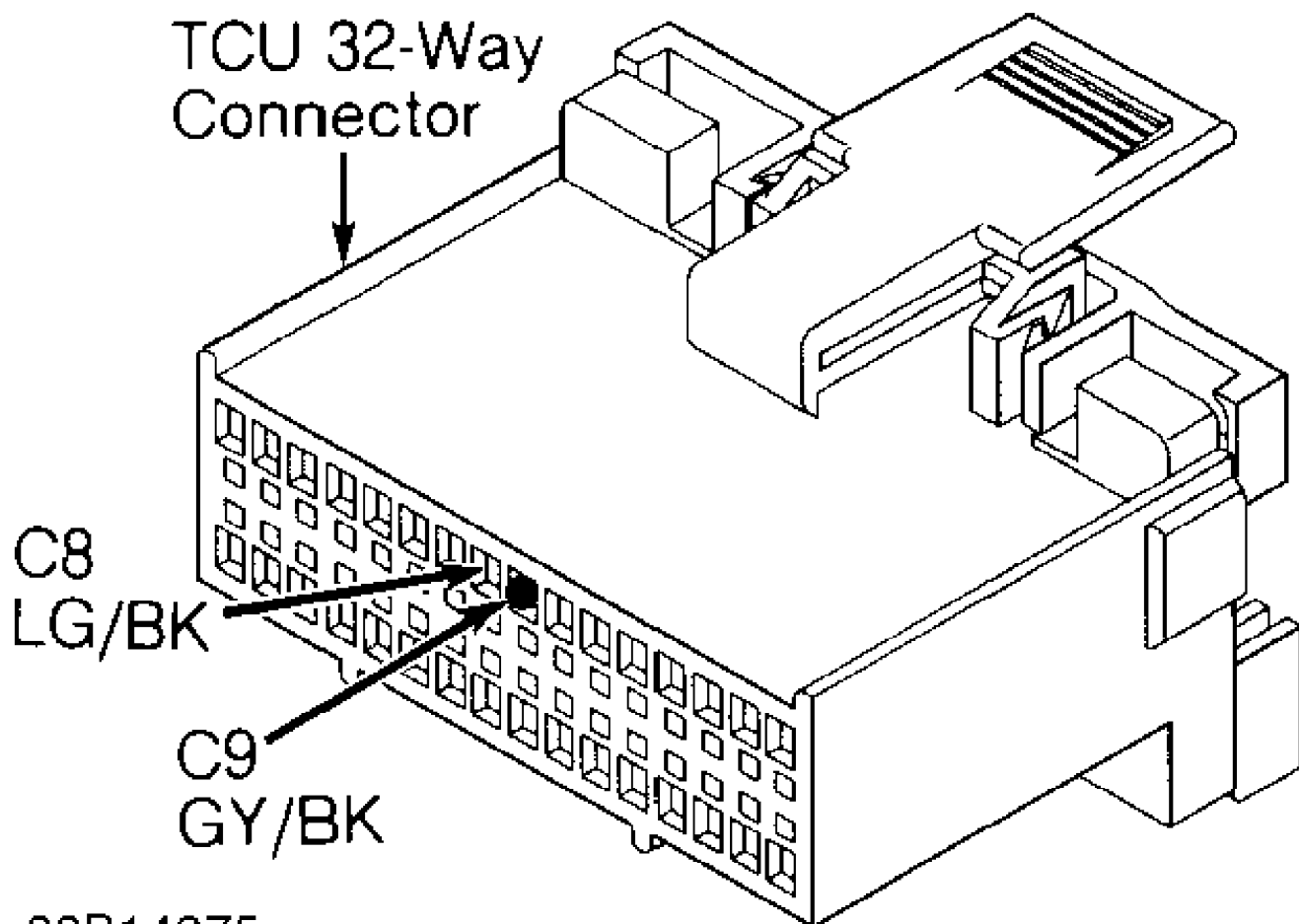
Fig. 76: Test 6D - Code 703, Flow Chart (2 of 3)



92A14258

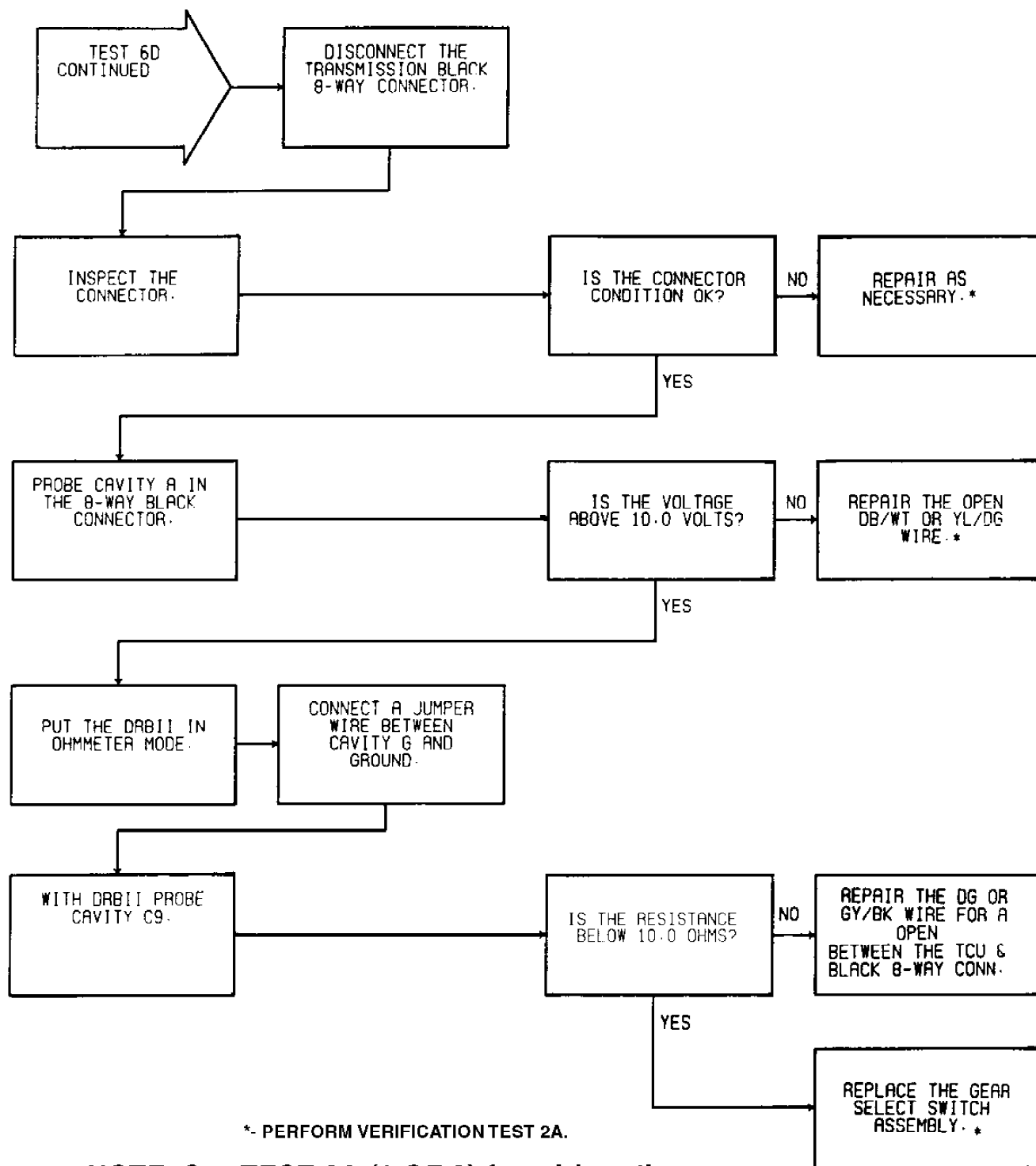
Fig. 77: Test 6D - Gear Select Switch Schematic (Cherokee)

## XJ BODY



92B14275

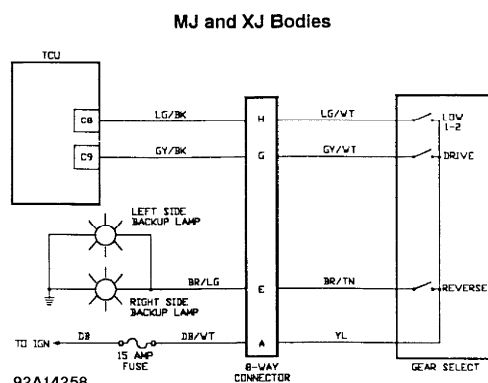
Fig. 78: Test 6D - TCU 32-Way Connector (Cavities 8 & 9, Cherokee)



**NOTE: See TEST 6A (1 OF 2) for wiring diagram.**

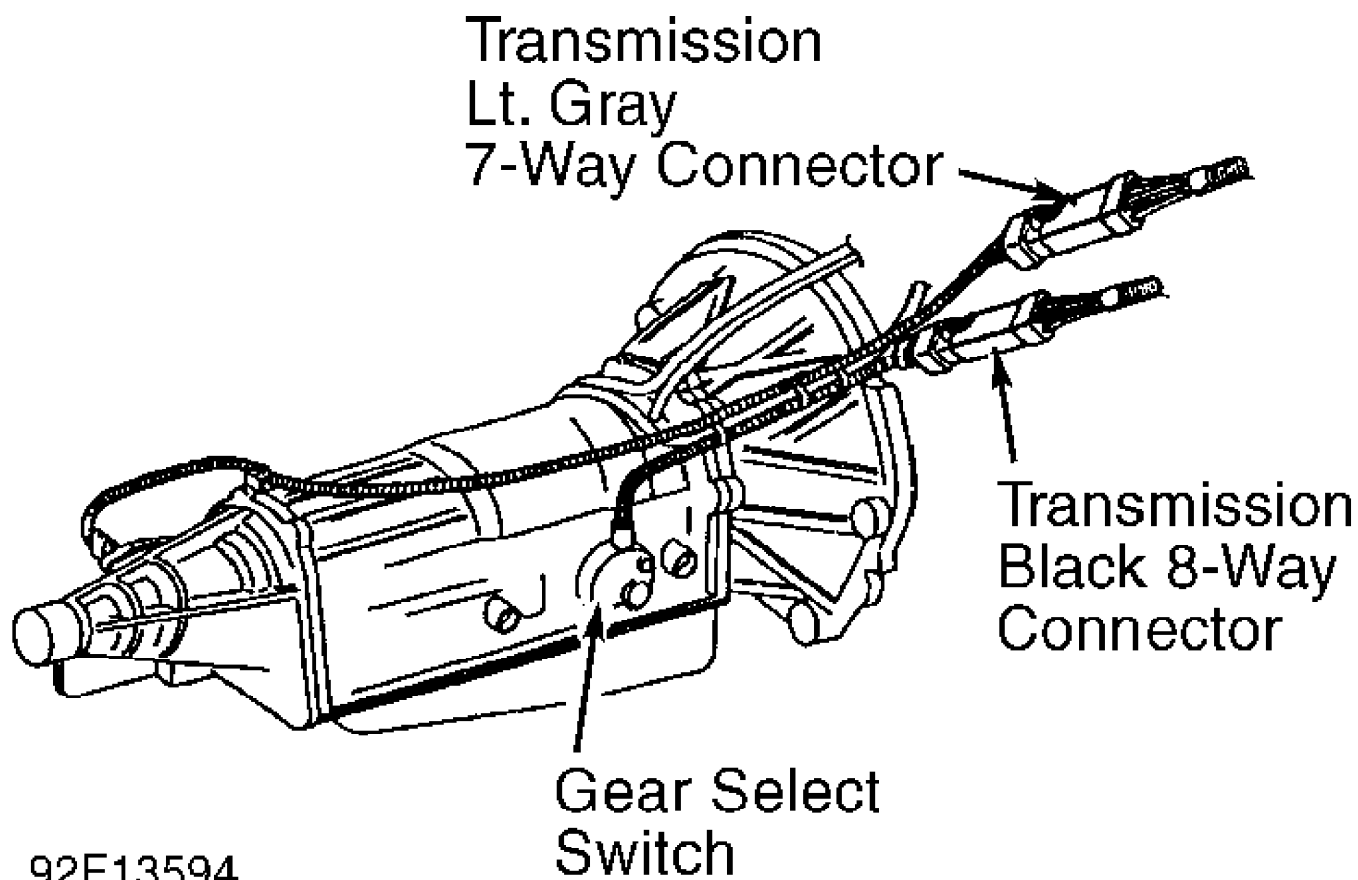
92E14278

Fig. 79: Test 6D - Code 703, Flow Chart (3 of 3)



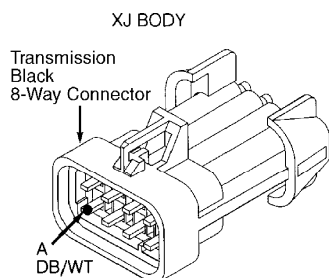
92A14258

Fig. 80: Test 6D - Gear Select Switch Schematic (Cherokee)



**92F13594**

Fig. 81: Test 6D - Code 703, Location of Gear Select Switch

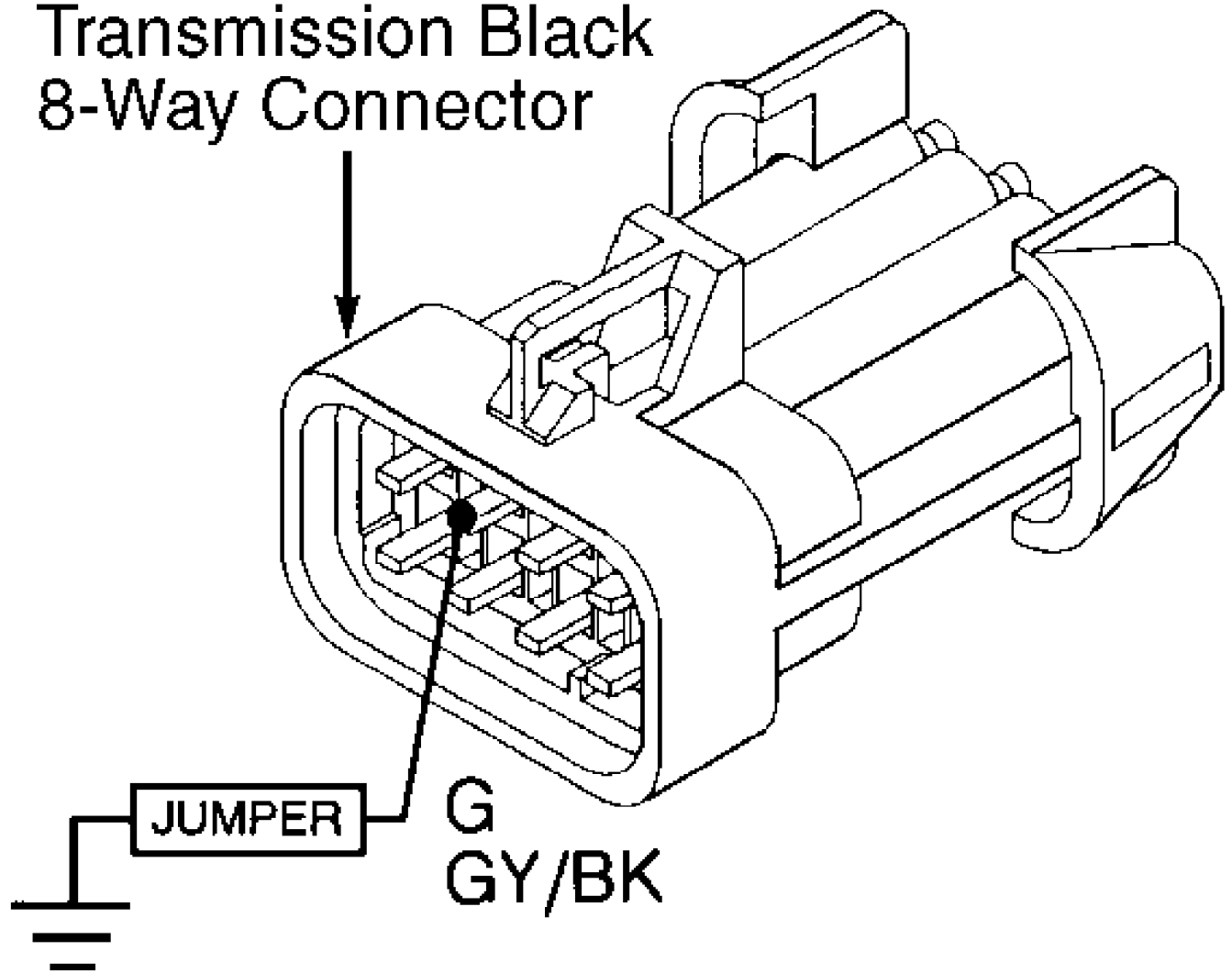


92A14266

Fig. 82: Test 6D - 8-Way Black Connector Cavity "A" (Cherokee)

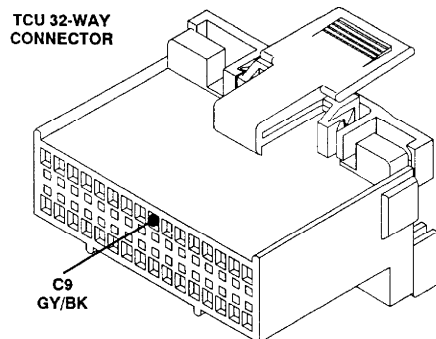
## XJ BODY

Transmission Black  
8-Way Connector



92F14279

Fig. 83: Test 6D - 8-Way Black Connector Cavity "G" (Cherokee)



ZJ Body: DG

92I14264

Fig. 84: Test 6D - Code 703, TCU 32-Way Connector (Cavity 9)

### TEST 6E - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6D - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

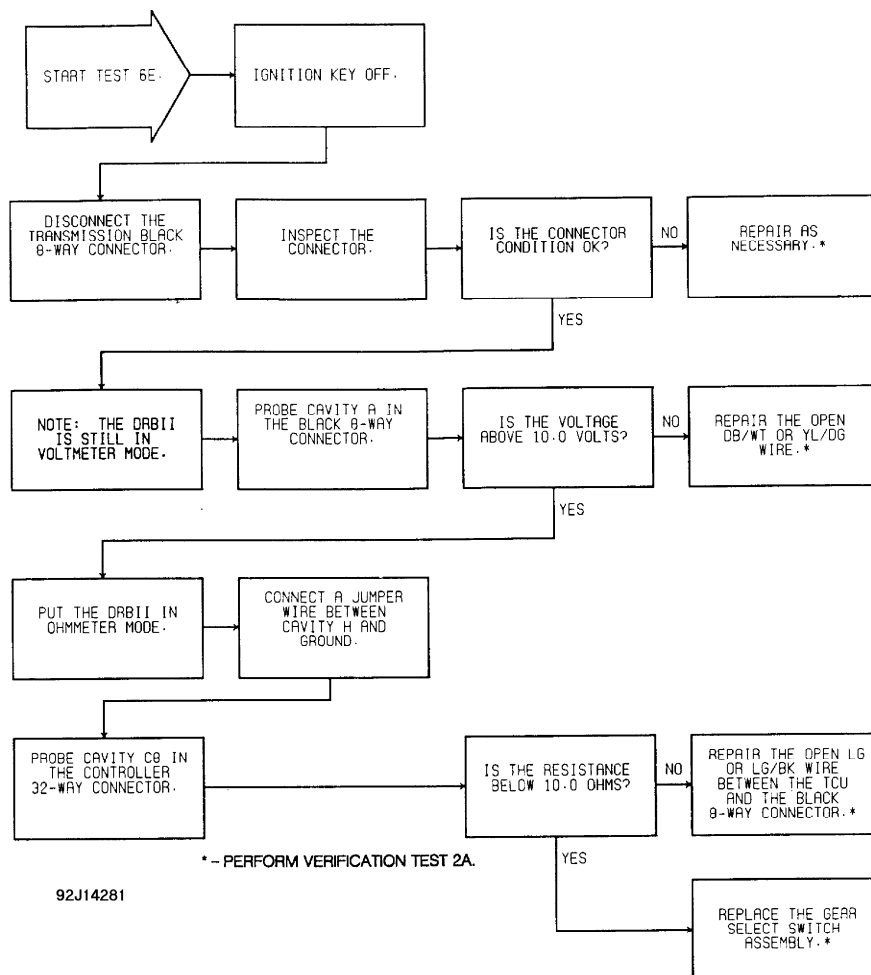
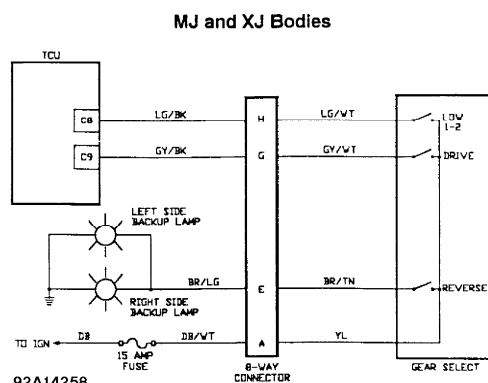


Fig. 85: Test 6E - Code 703, Flow Chart



92A14258

Fig. 86: Test 6E - Gear Select Switch Schematic (Cherokee)

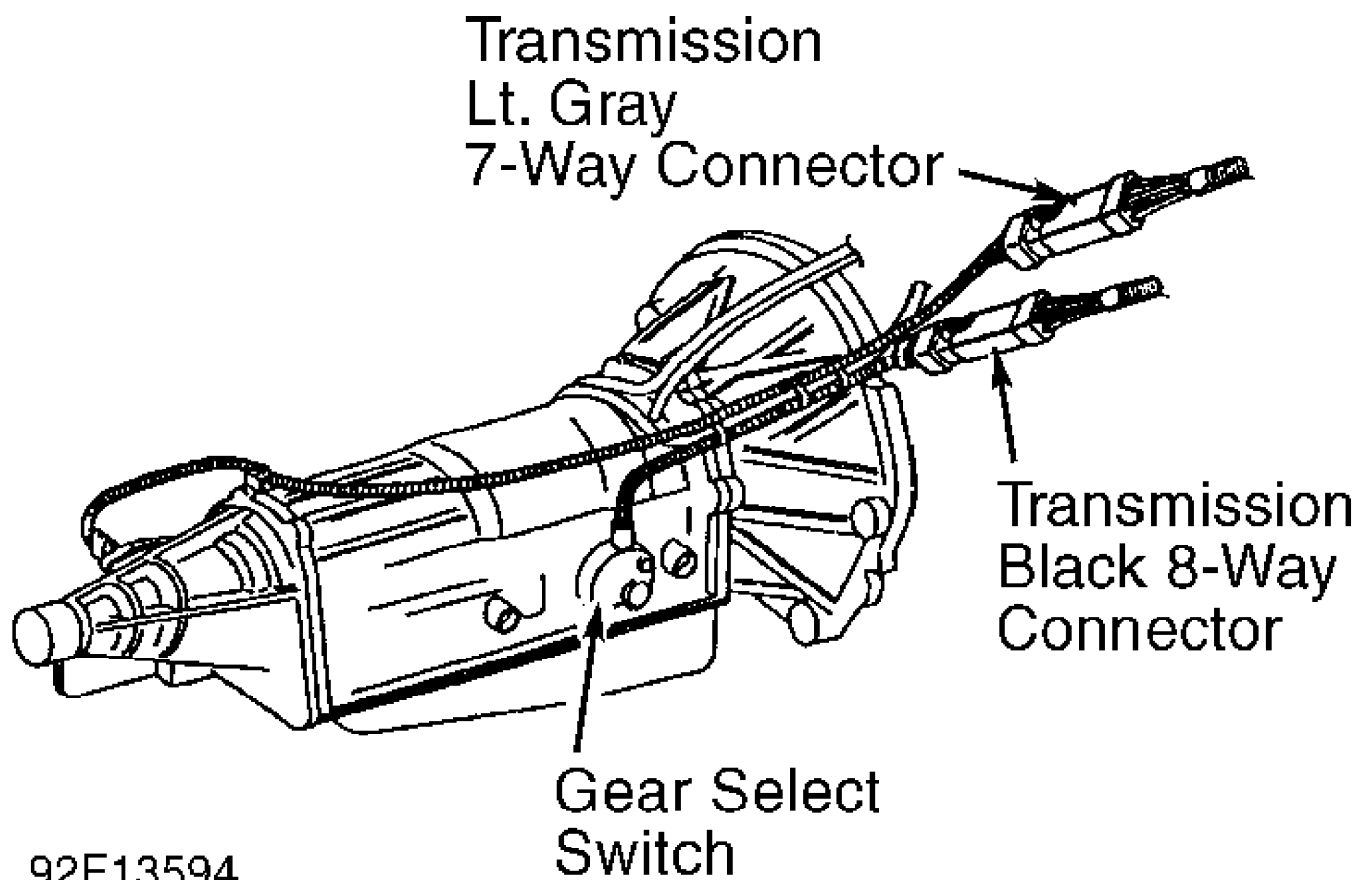
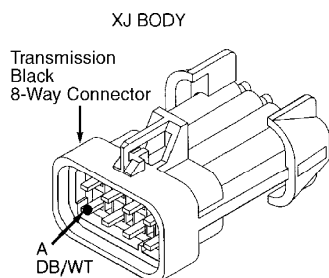


Fig. 87: Test 6E - Code 703, Location of Gear Select Switch



92A14266

Fig. 88: Test 6E - 8-Way Black Connector Cavity "A" (Cherokee)

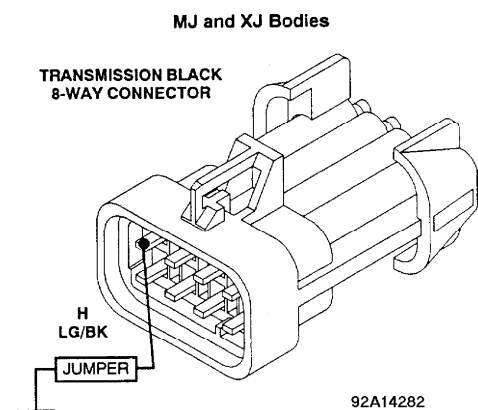


Fig. 89: Test 6E - 8-Way Black Connector Cavity "H" (Cherokee)

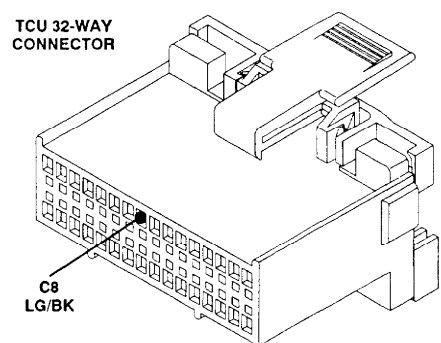


Fig. 90: Test 6E - TCU 32-Way Connector (Cavity 8)

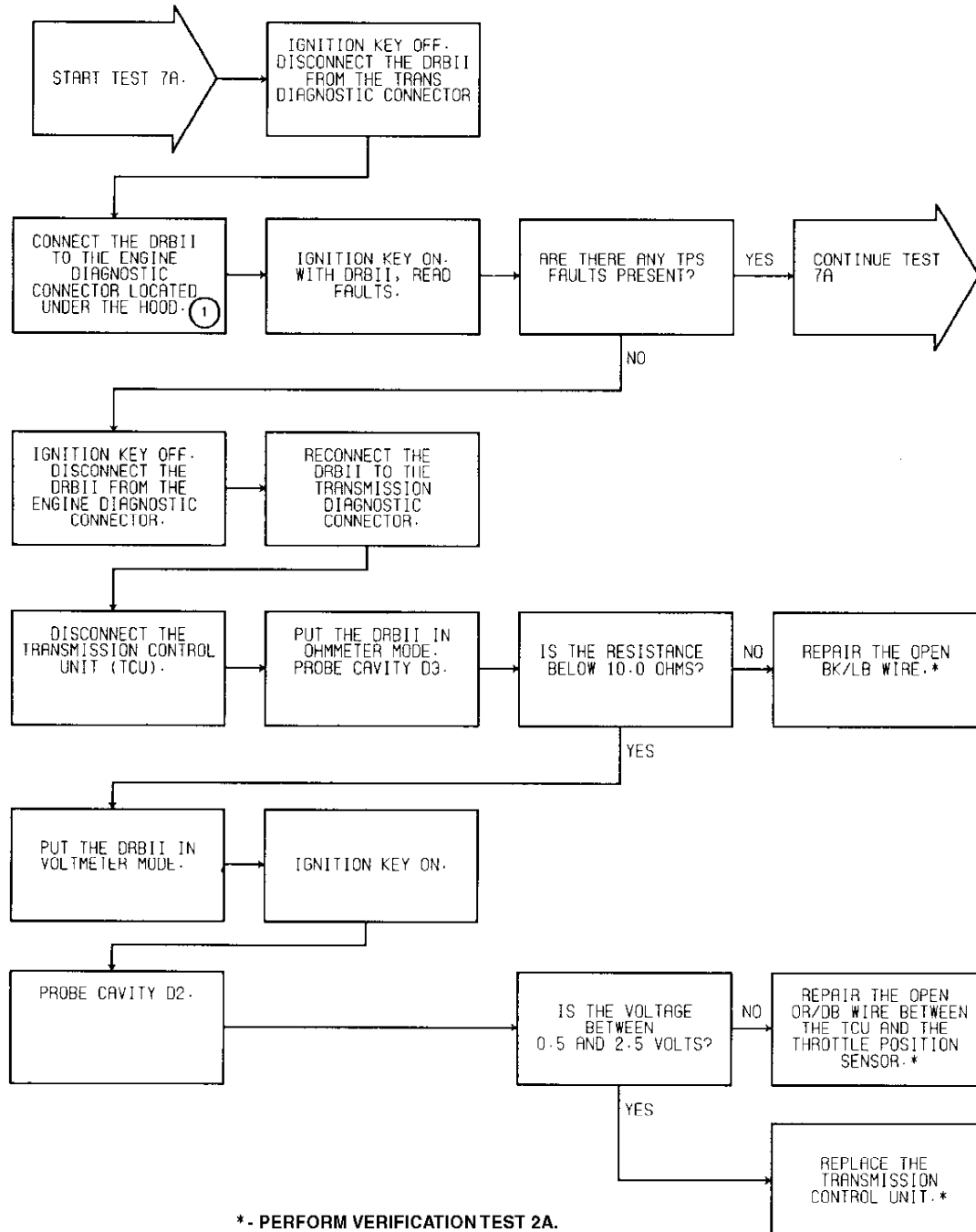
## TEST 7A - CODE 705 - TPS CIRCUIT

**NOTE:** Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

**NOTE:** On Cherokee, engine diagnostic connector is located at left side of engine compartment, near engine controller. Engine diagnostic connector is a 6-terminal connector.

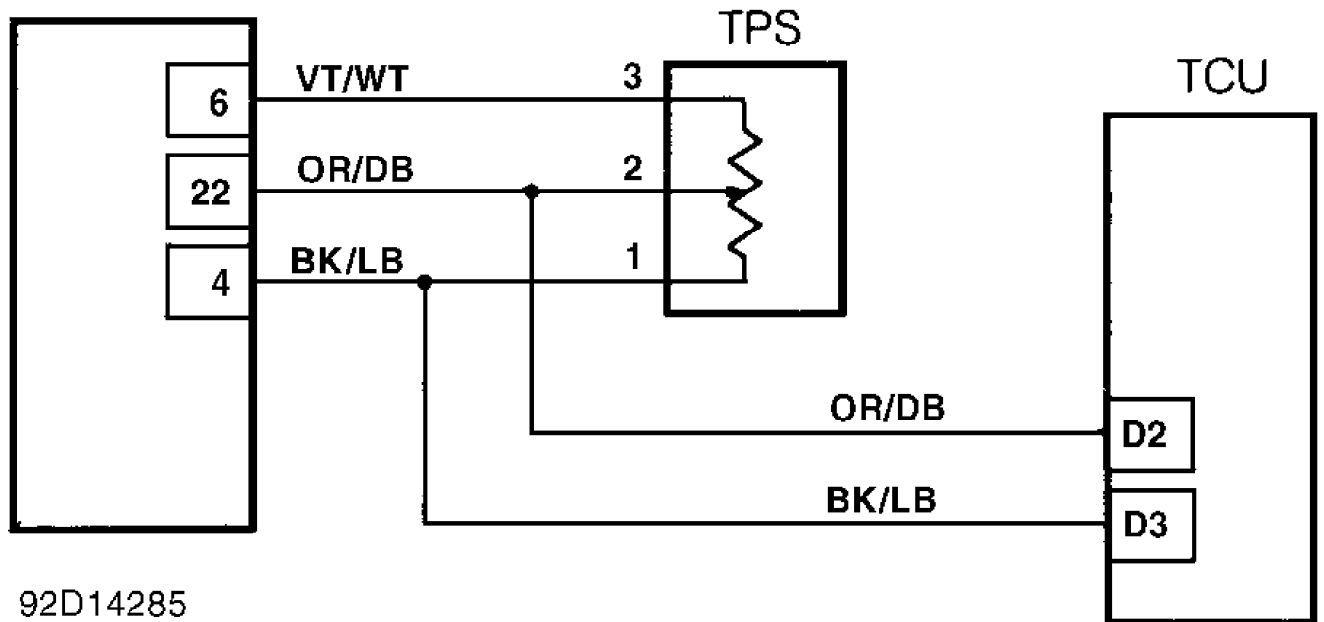


**Perform TEST 6D before proceeding.**



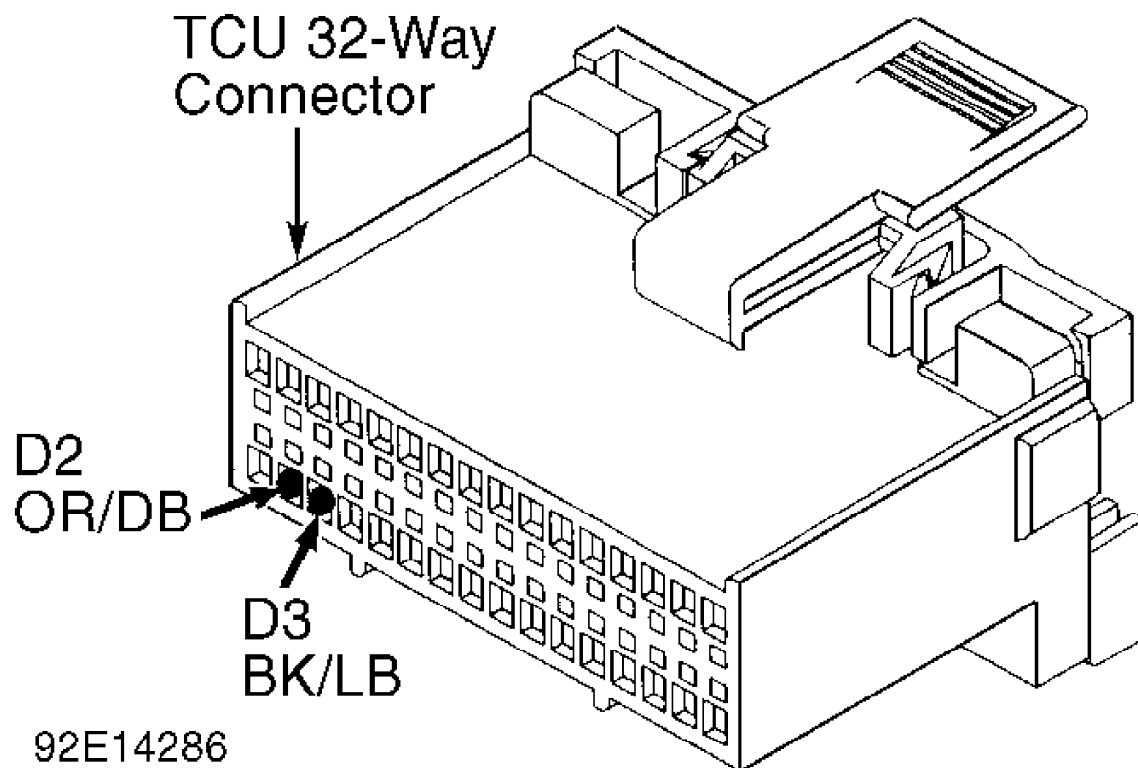
① - On XJ models, engine diagnostic connector is located at left side of engine compartment, near engine controller.

## ENGINE CONTROLLER



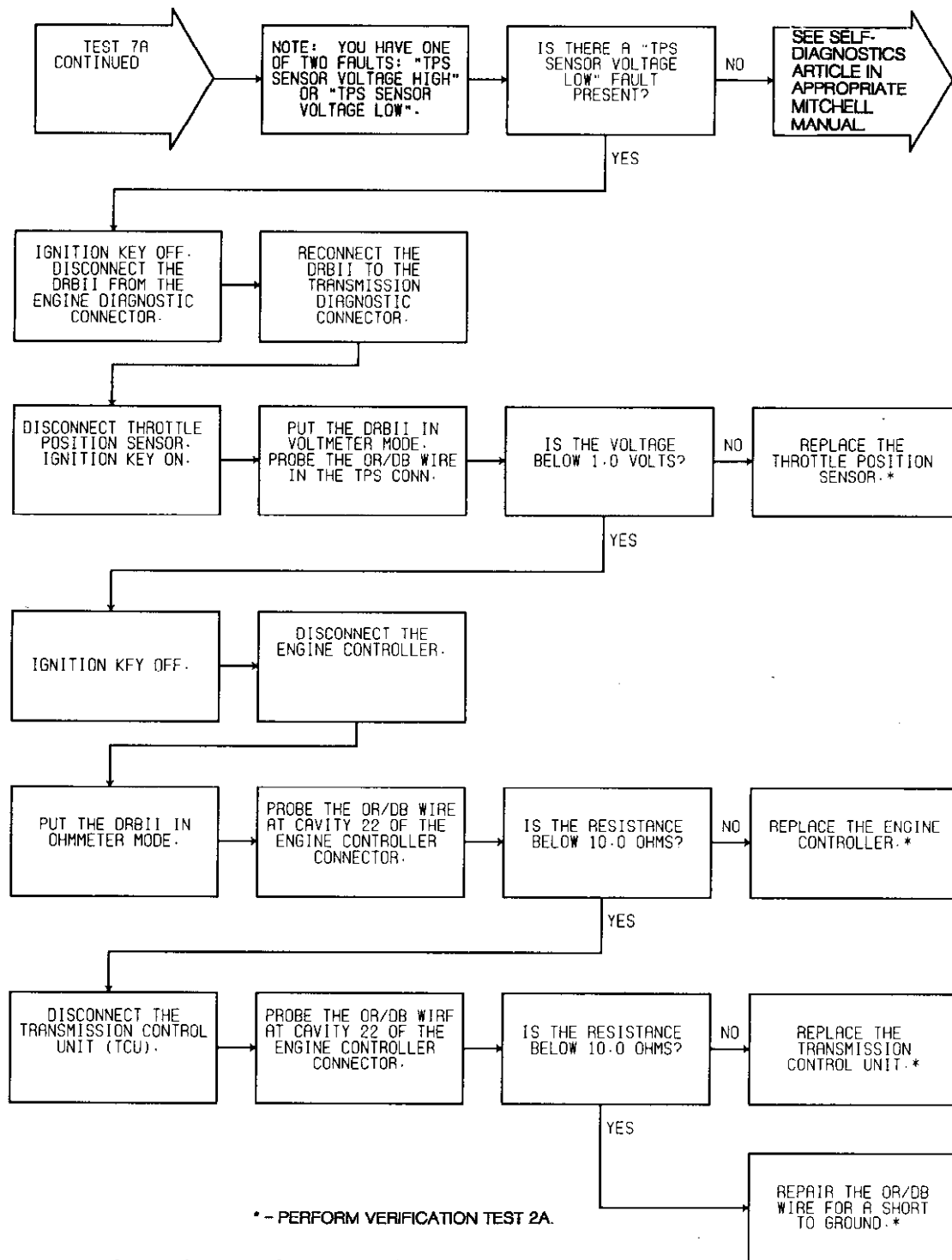
92D14285

Fig. 92: Test 7A - Code 705, Schematic



92E14286

Fig. 93: Test 7A - TCU 32-Way Connector (Cavities D2 & D3)

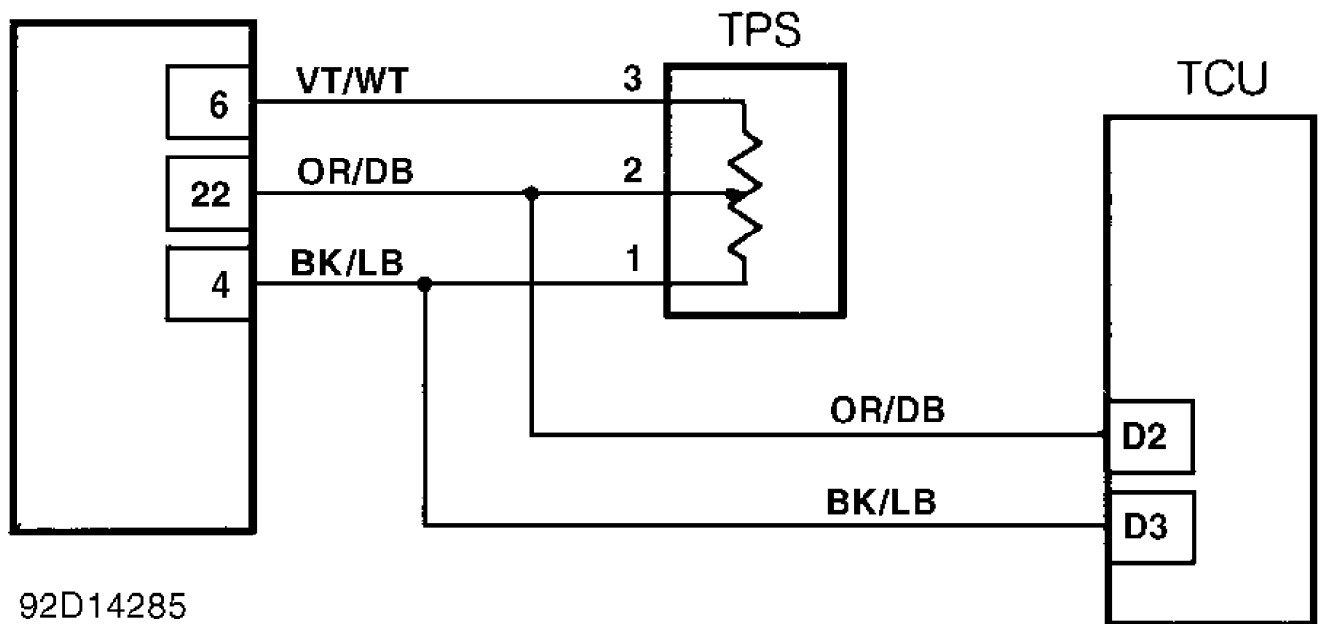


**NOTE: See TEST 7A (1 OF 2) for wiring diagram.**

92F14287

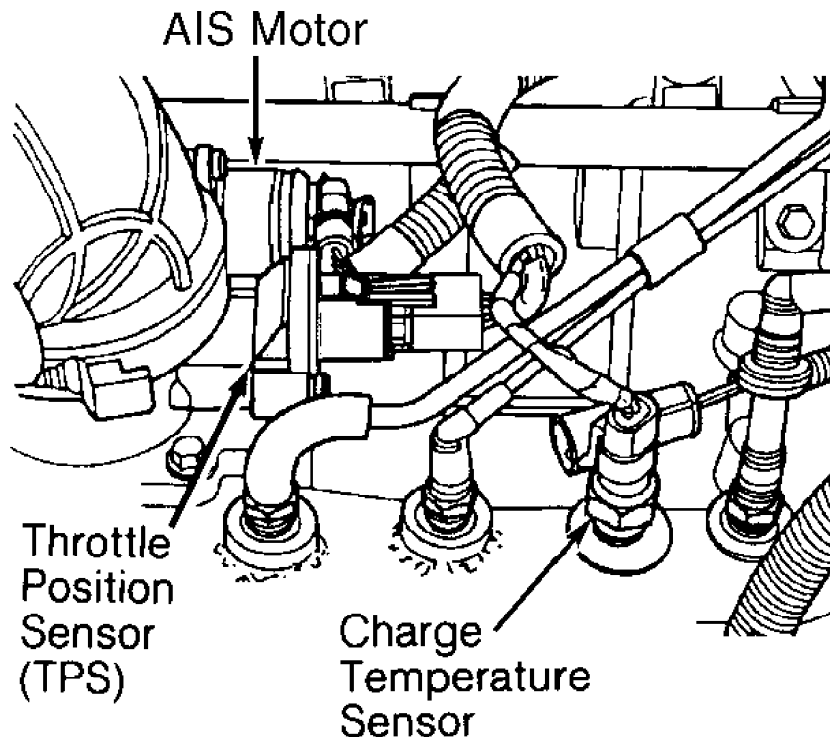
Fig. 94: Test 7A - Code 705, Flow Chart (2 of 2)

## ENGINE CONTROLLER



92D14285

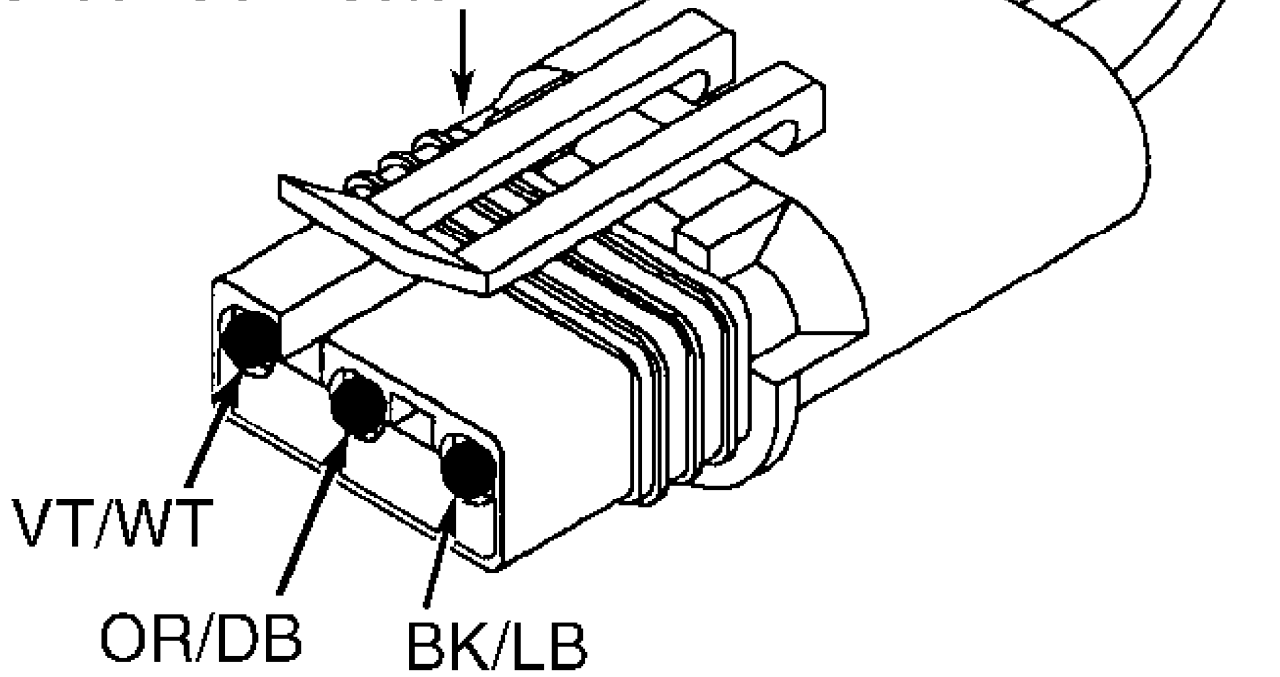
Fig. 95: Test 7A - Code 705, Schematic



92G14288

Fig. 96: Test 7A - Location of Throttle Position Sensor (TPS)

## Throttle Position Sensor Connector

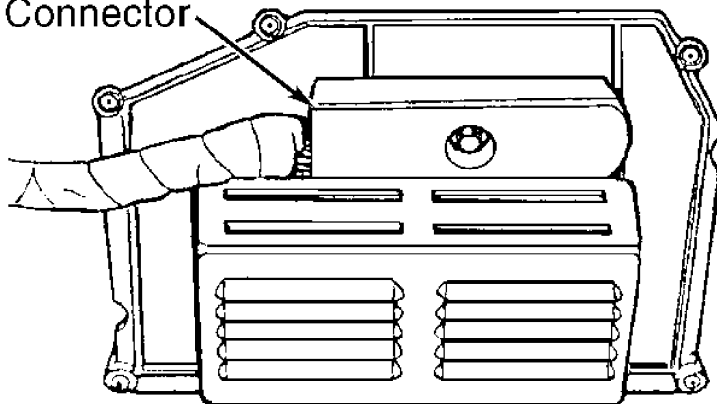


92H14289

Fig. 97: Test 7A - Code 705, View of TPS Connector

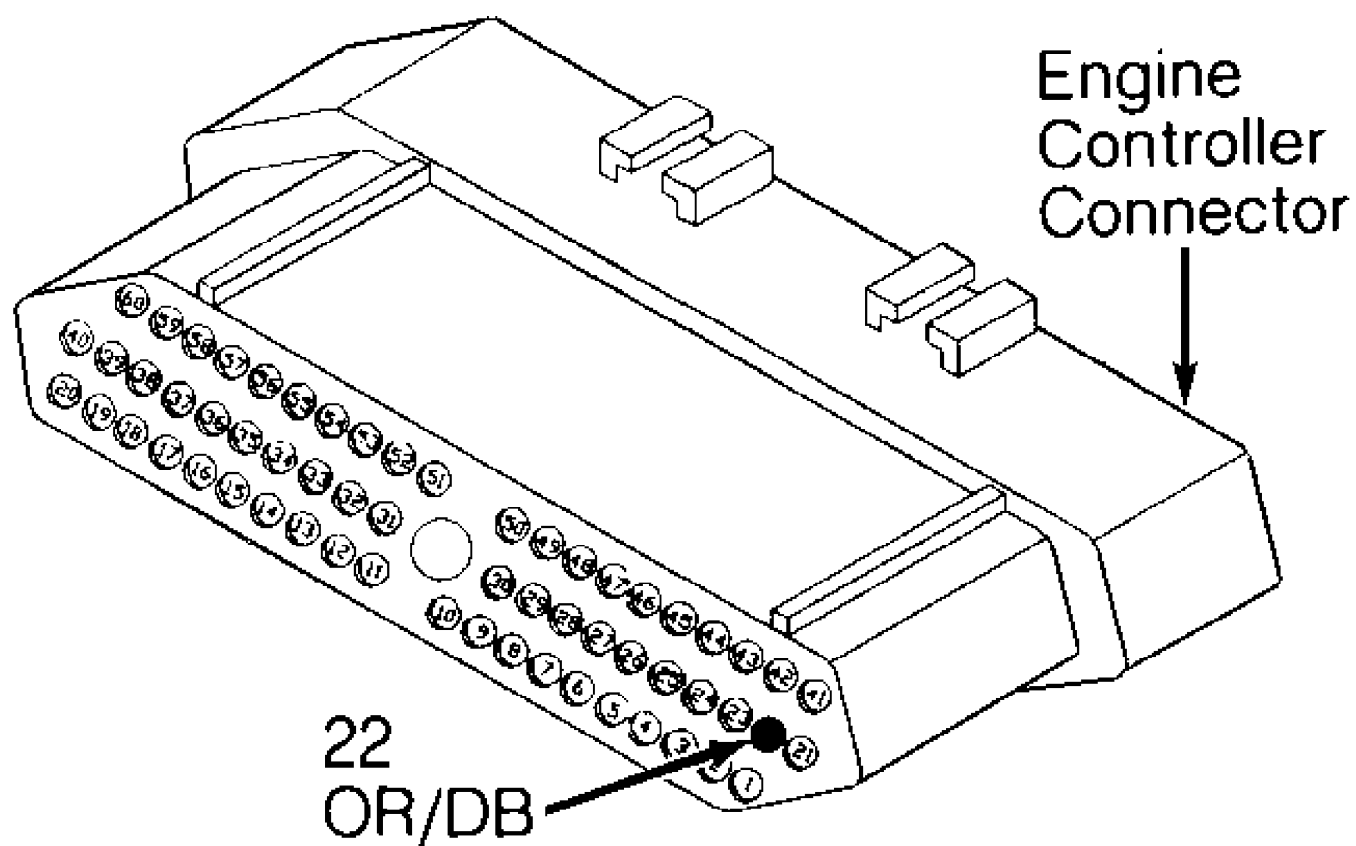
XJ BODY

## Engine Controller Connector



92A14290

Fig. 98: Test 7A - Location of Engine Control Connector (Cherokee)



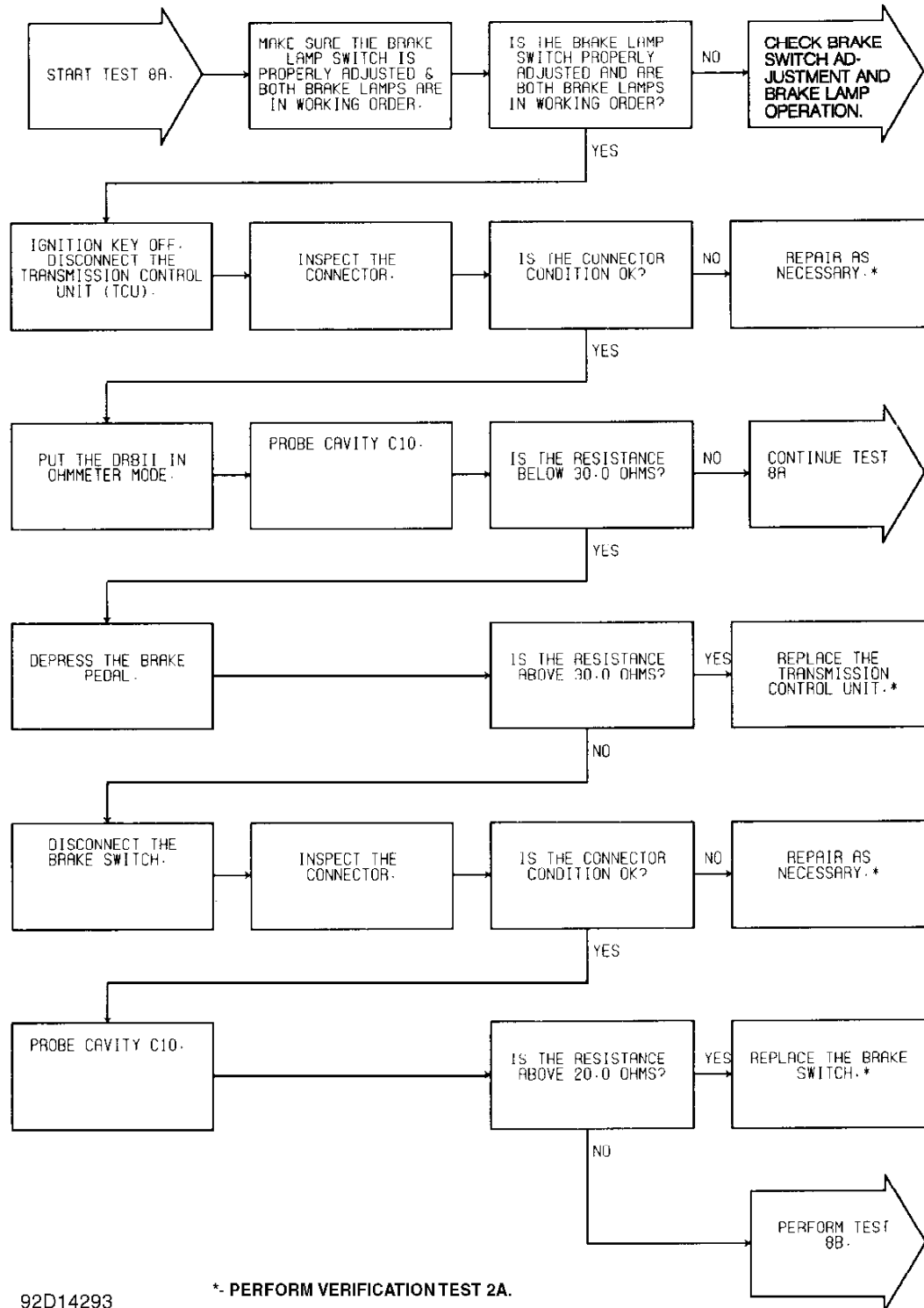
92C14292

Fig. 99: Test 7A - View of Engine Control Connector (Cavity 22)

#### TEST 8A - CODE 706 - BRAKE SWITCH CIRCUIT

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

Perform TEST 1A before proceeding.



92D14293

\*- PERFORM VERIFICATION TEST 2A.

Fig. 100: Test 8A - Code 706, Flow Chart

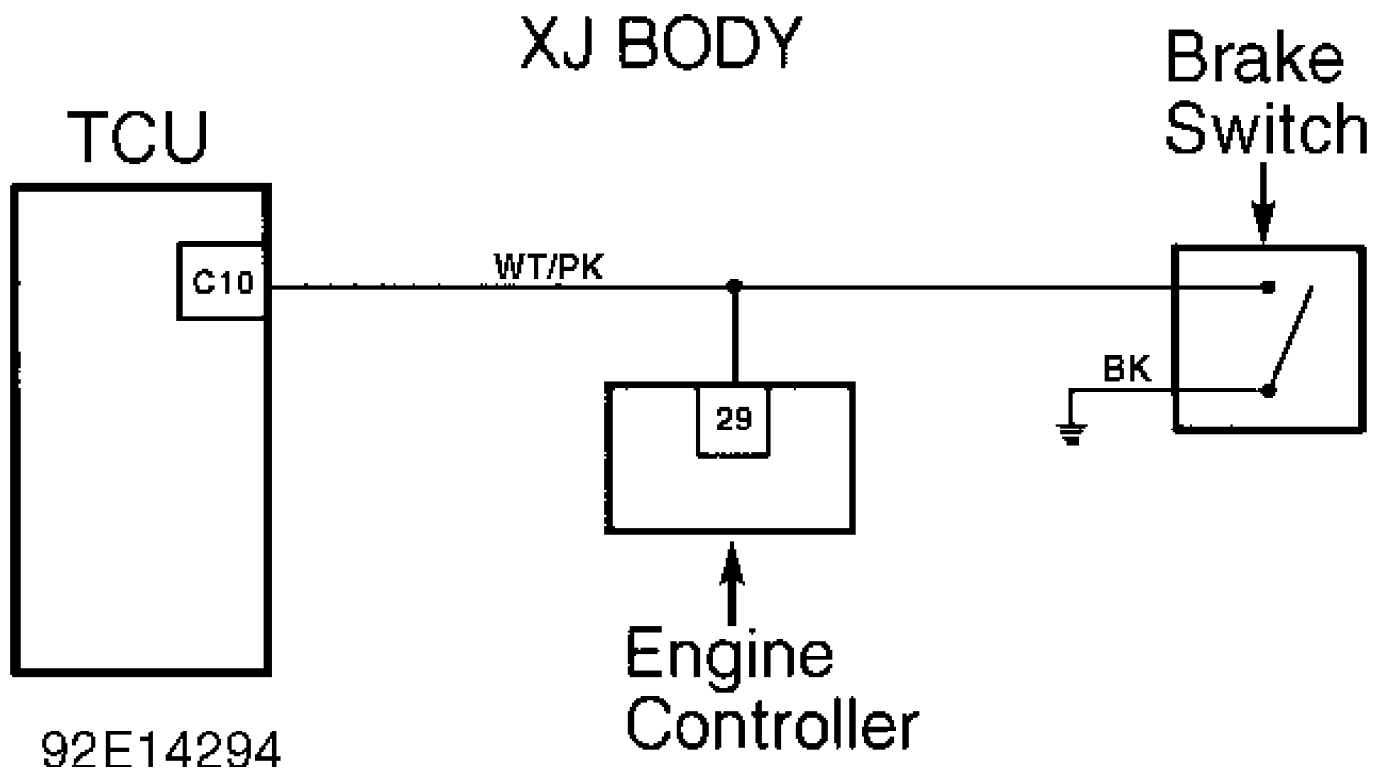


Fig. 101: Test 8A - Code 706, Schematic (Cherokee)

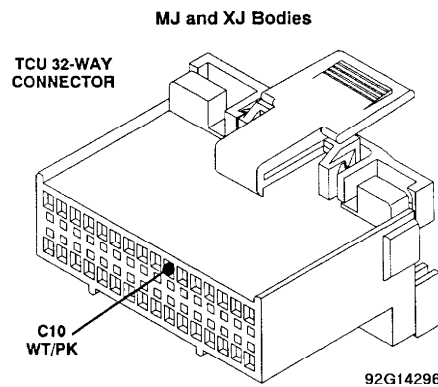


Fig. 102: Test 8A - TCU 32-Way Connector (Cavity 10, Cherokee)

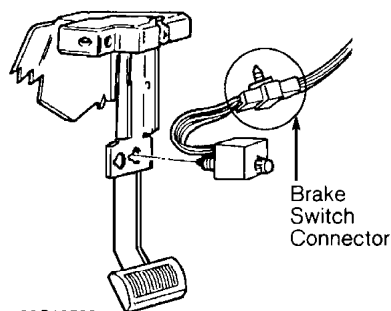


Fig. 103: Test 8A - Location of Brake Switch Connector



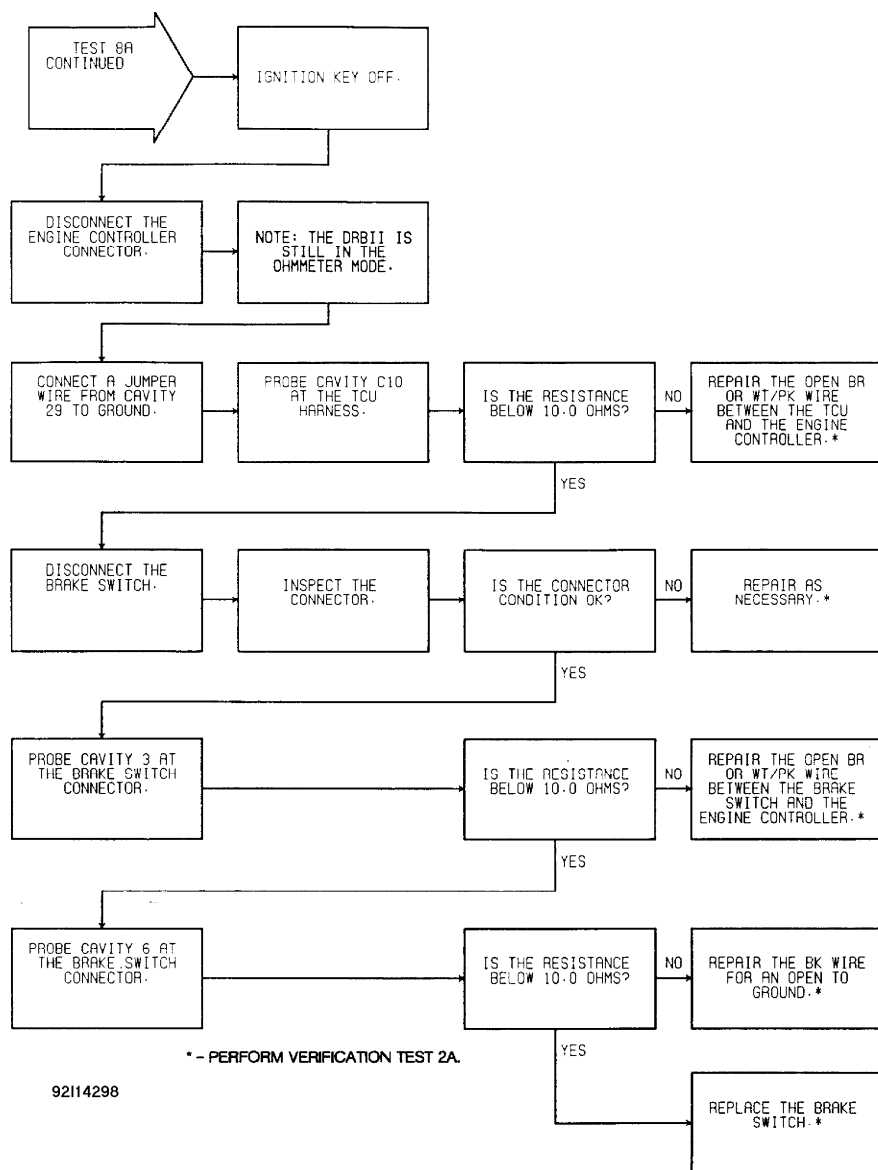


Fig. 104: Test 8A - Code 706, Flow Chart

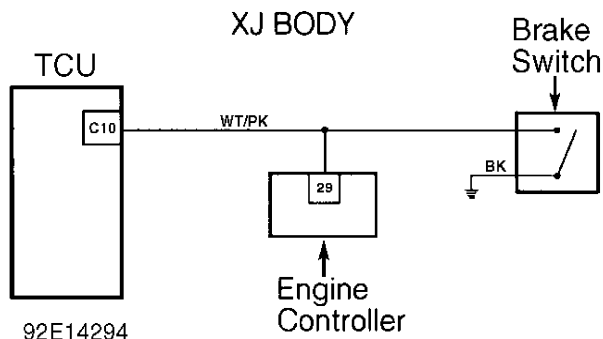


Fig. 105: Test 8A - Code 706, Schematic (Cherokee)

**MJ and XJ Bodies**  
**ENGINE CONTROLLER CONNECTOR**

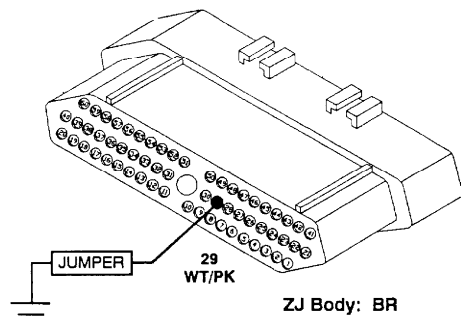


Fig. 106: Test 8A - View of Engine Controller Connector (Cavity 29)

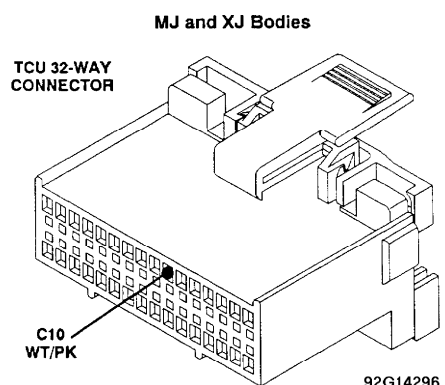
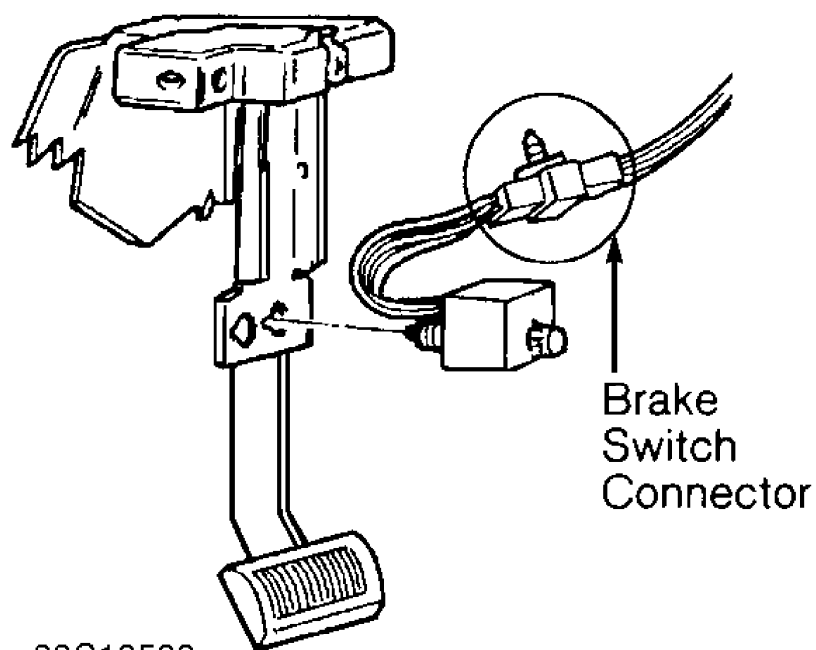


Fig. 107: Test 8A - TCU 32-Way Connector (Cavity 10, Cherokee)



92C13583

Fig. 108: Test 8A - Location of Brake Switch Connector

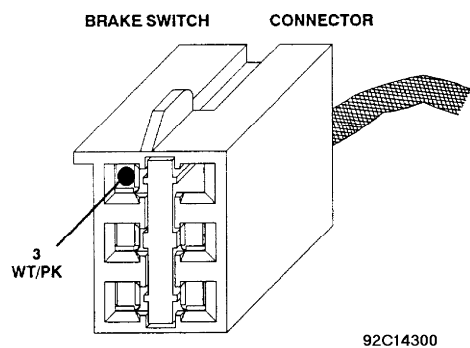


Fig. 109: Test 8A - View of Brake Switch Connector (Cavity 3)

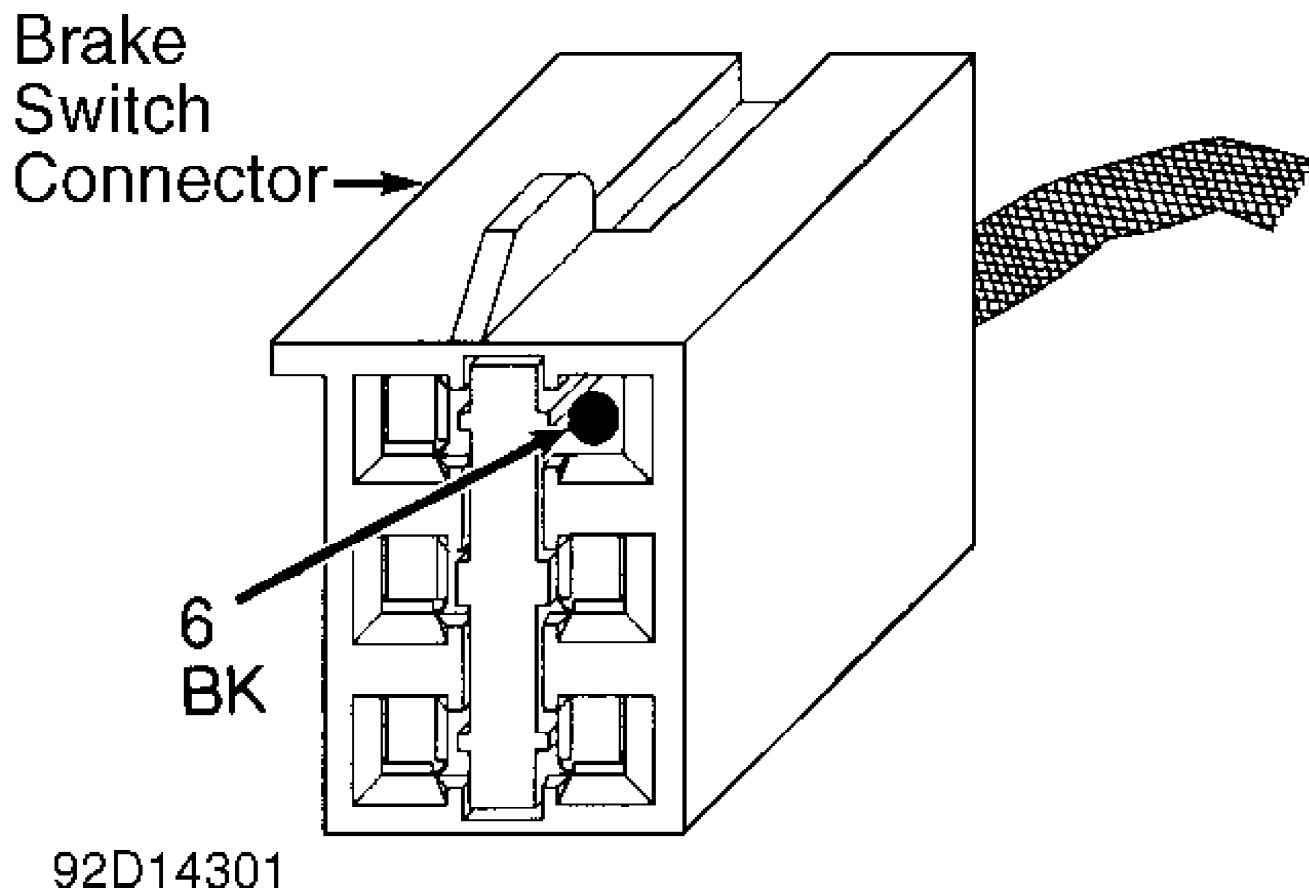
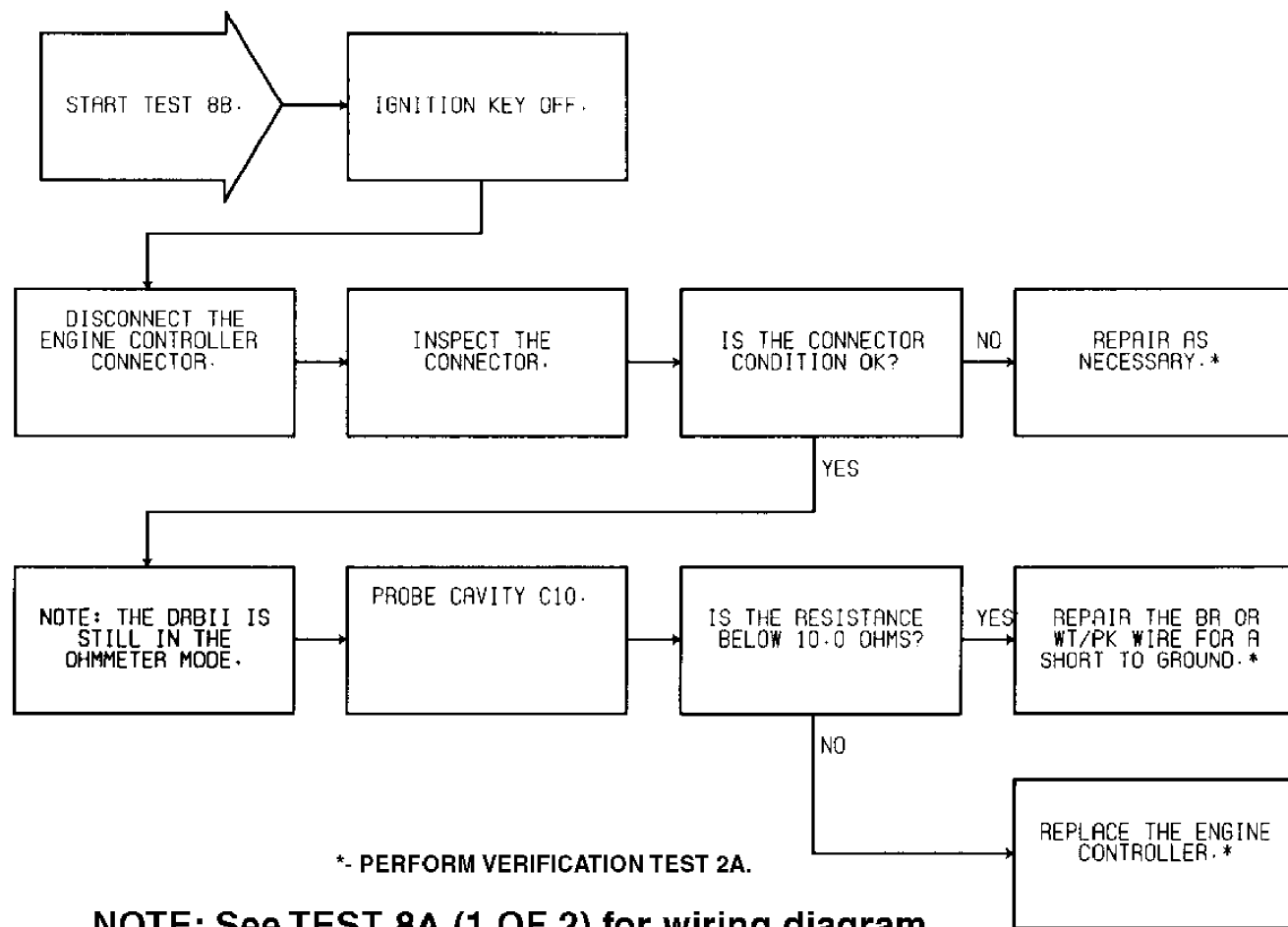


Fig. 110: Test 8A - View of Brake Switch Connector (Cavity 6)

#### TEST 8B - CODE 706 - BRAKE SWITCH CIRCUIT

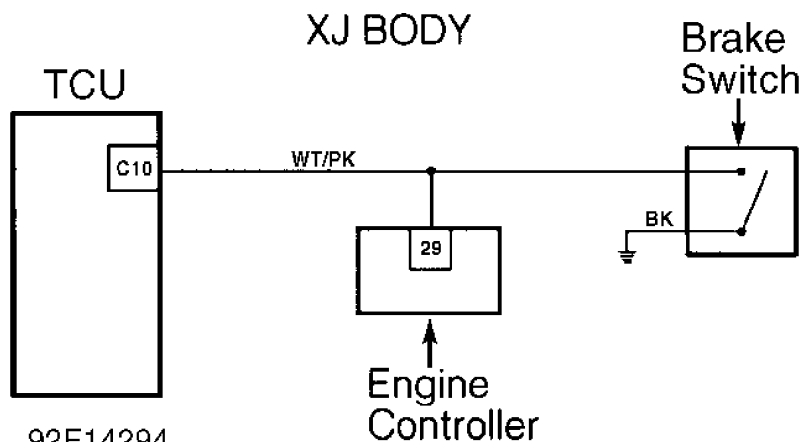
NOTE: Perform TEST 8A - CODE 706 - BRAKE SWITCH CIRCUIT before proceeding.

**Perform TEST 8A before proceeding.**



92E14302

Fig. 111: Test 8B - Code 706, Flow Chart

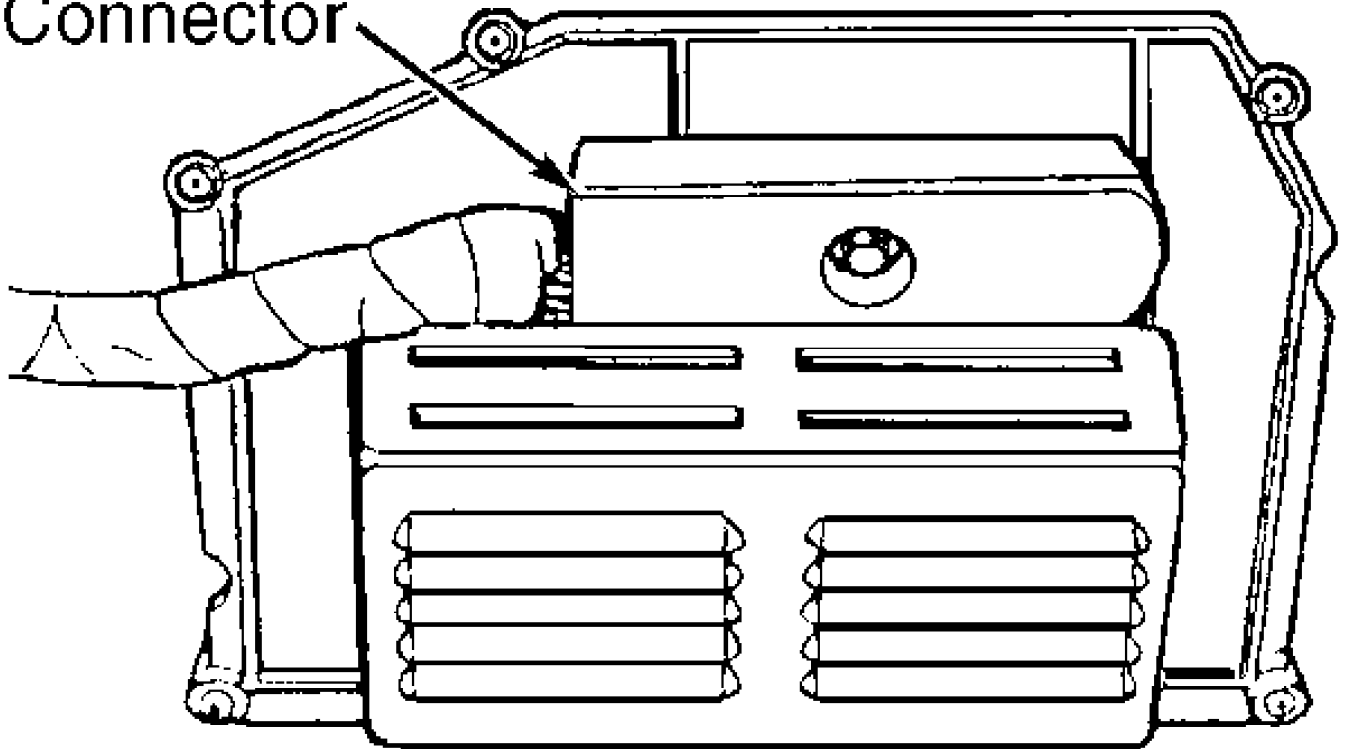


92E14294

Fig. 112: Test 8B - Code 706, Schematic (Cherokee)

# XJ BODY

## Engine Controller Connector



92A14290

Fig. 113: Test 7A - Location of Engine Control Connector (Cherokee)

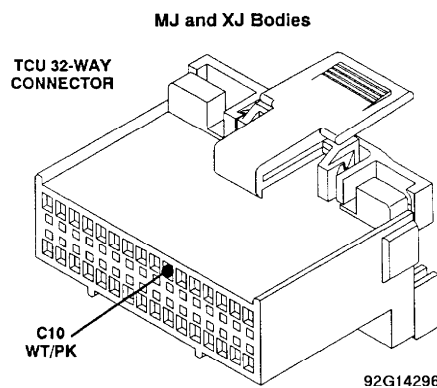


Fig. 114: Test 8B - TCU 32-Way Connector (Cavity 10, Cherokee)

### TEST 9A - WRONG TCU

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.

NOTE: The AW-4 is used only on 4.0L. In earlier years, it was

used with 2.5L

The DRB-II has determined that the wrong Transmission Control Unit (TCU) has been installed in the vehicle. There are two transmission control units available for the Jeep AW4 transmission. One is for the 4-cylinder 2.5L engine and the other is for the 6-cylinder 4.0L engine.

1) using the DRB-II, read MODULE INFO. See HELP 1 for assistance.

2) Determine what vehicle should be in the vehicle.

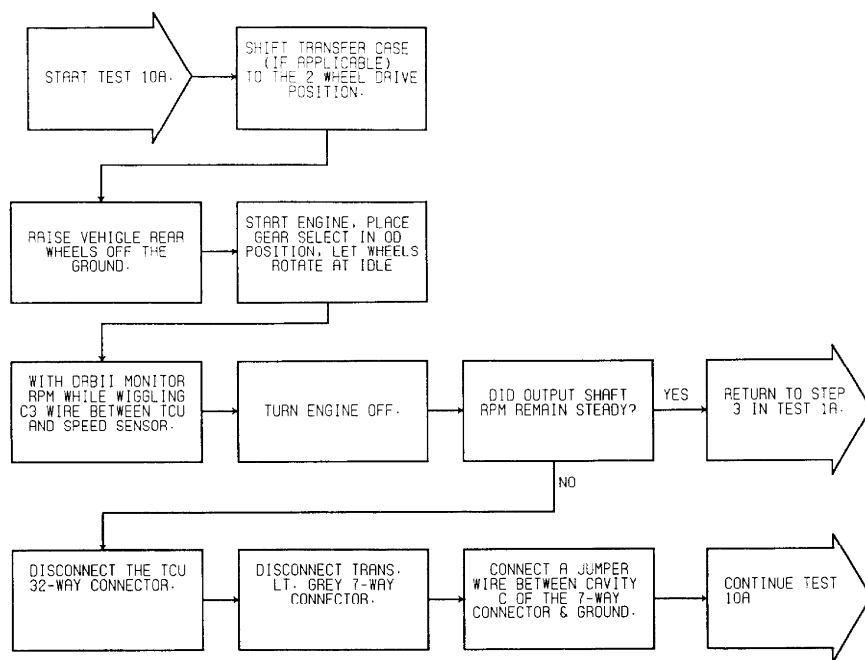
\* 2.5L Engine: TCU 02 (Used in earlier years only)

\* 4.0L Engine: TCU 01 (1993-94)

3) If the wrong transmission control unit is installed, the vehicle shift points will be slightly different (the 2.5L engine TCU has higher shift points).

## TEST 10A - TESTING FOR INTERMITTENT SPEED SENSOR

NOTE: Perform TEST 1A - VERIFICATION OF THE COMPLAINT before proceeding.



\* - PERFORM VERIFICATION TEST 2A.

92G14304

Fig. 115: Test 10A - Flow Chart (1 of 2)

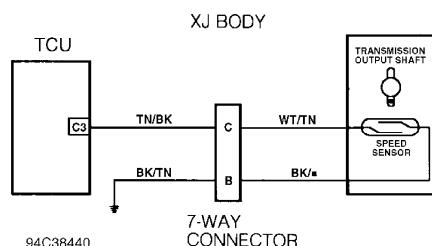


Fig. 116: Test 10A - Schematic (Cherokee)

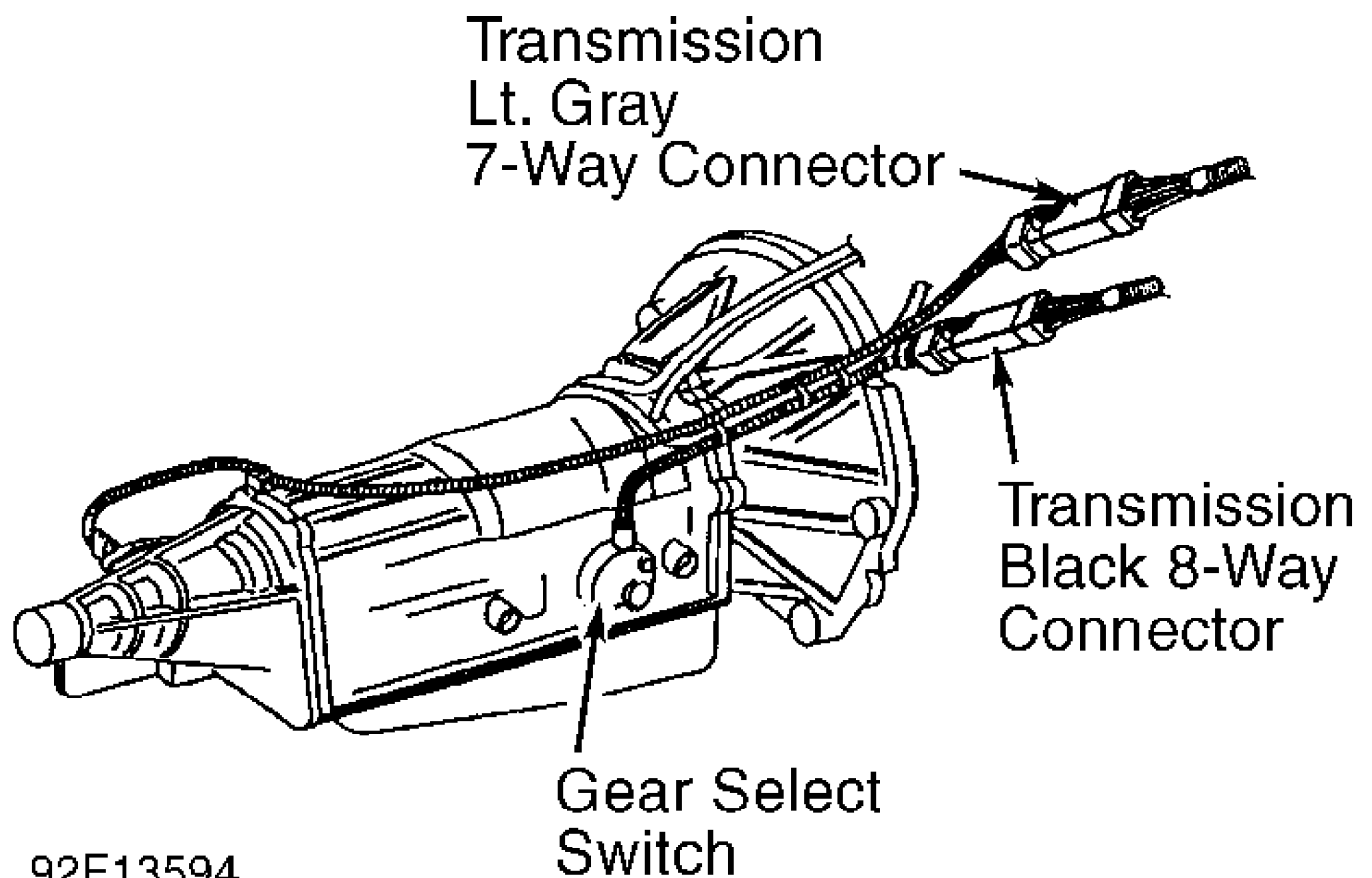
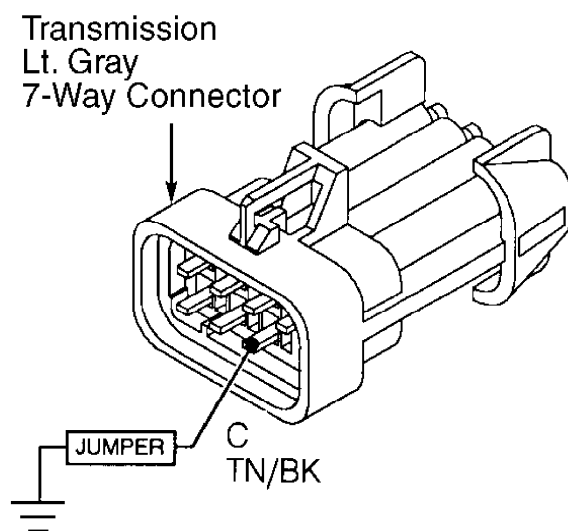


Fig. 117: Test 10A - Location of Transmission Connectors

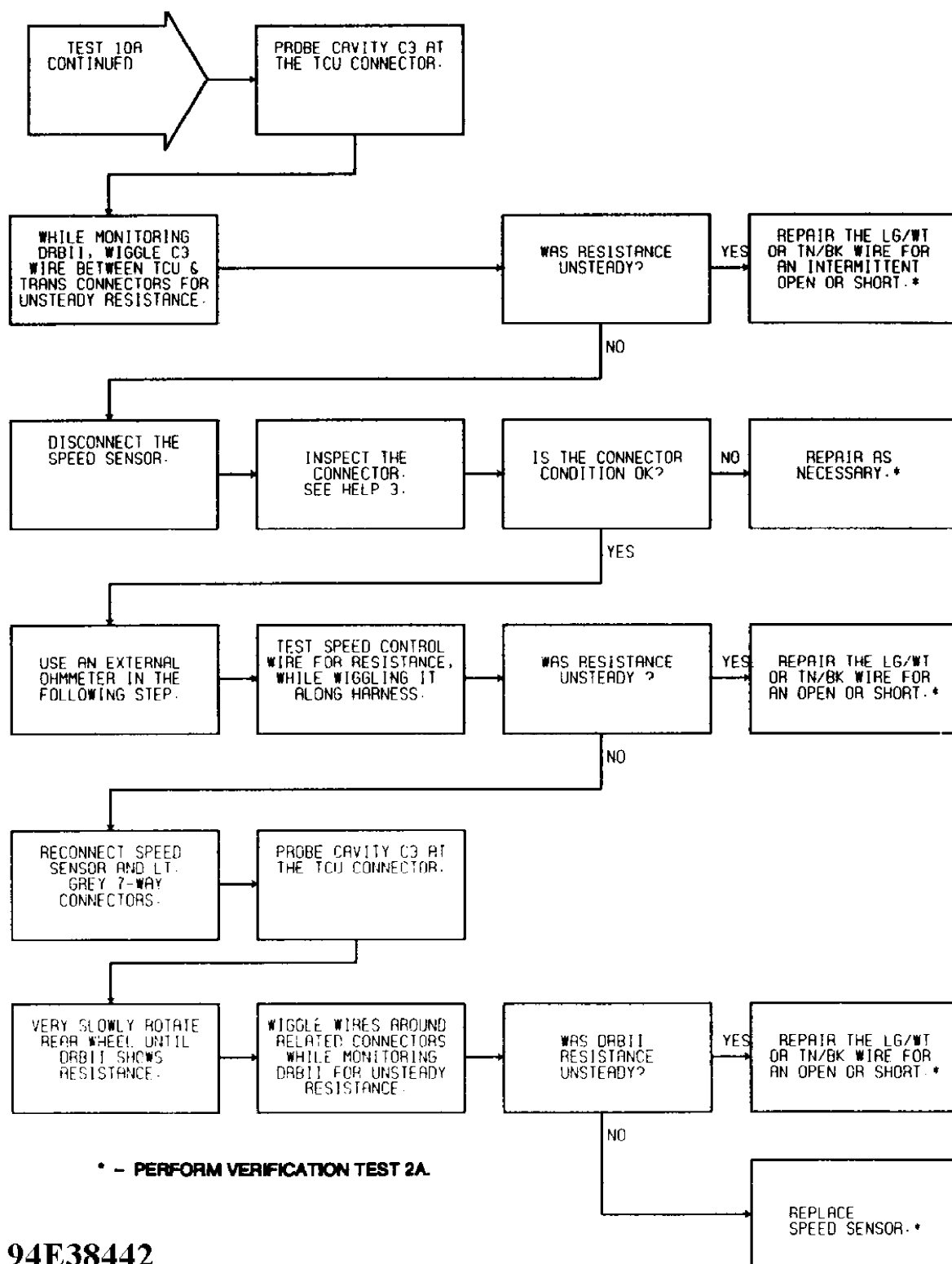
XJ BODY



94D38441

Fig. 118: Test 10A - View of 7-Way Connector (Cherokee)

NOTE: See Fig. 115 for wiring diagram.



94E38442

Fig. 119: Test 10A - Flow Chart (2 of 2)



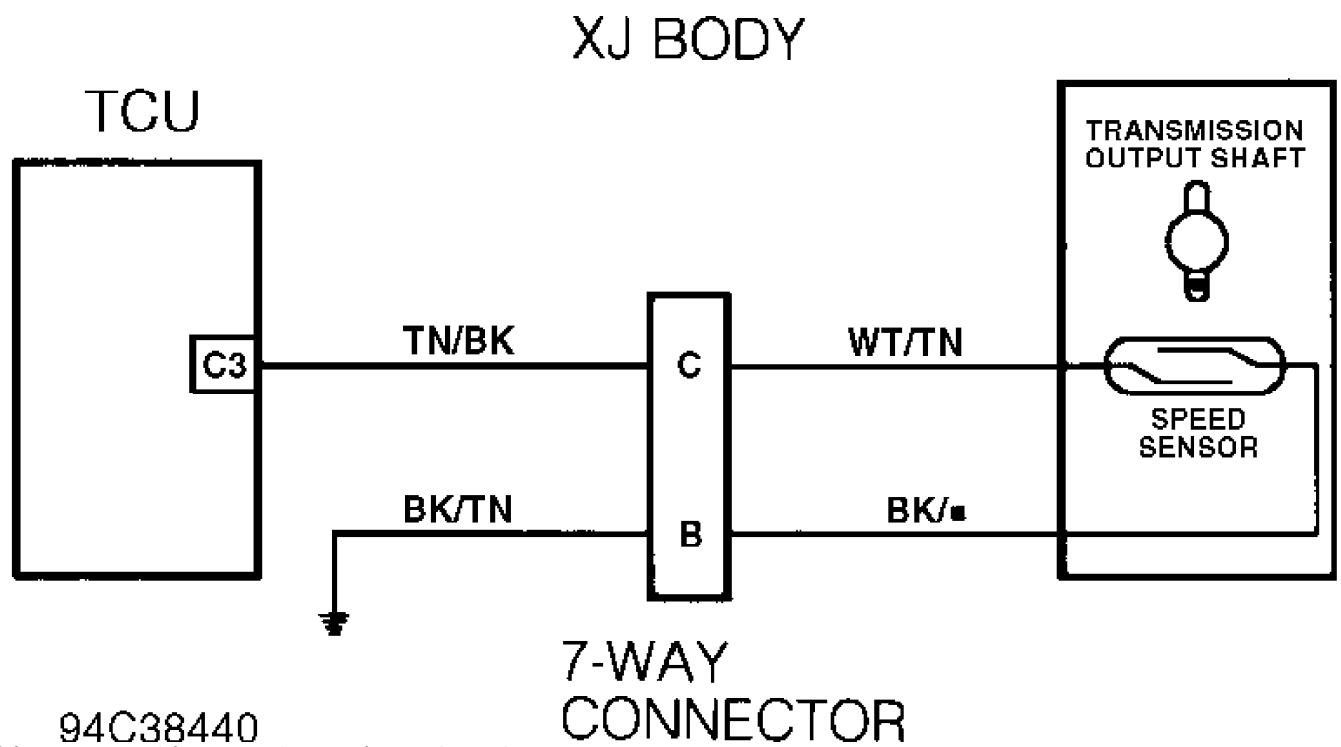


Fig. 120: Test 10A - Schematic (Cherokee)

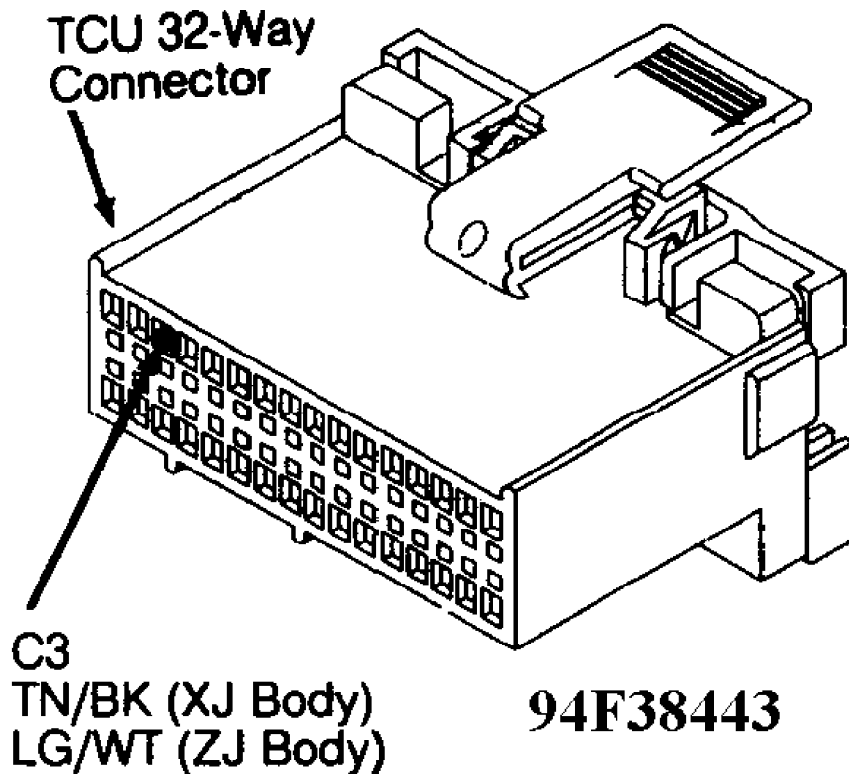


Fig. 121: Test 10A - TCU 32-Way Connector (Cavity 3)

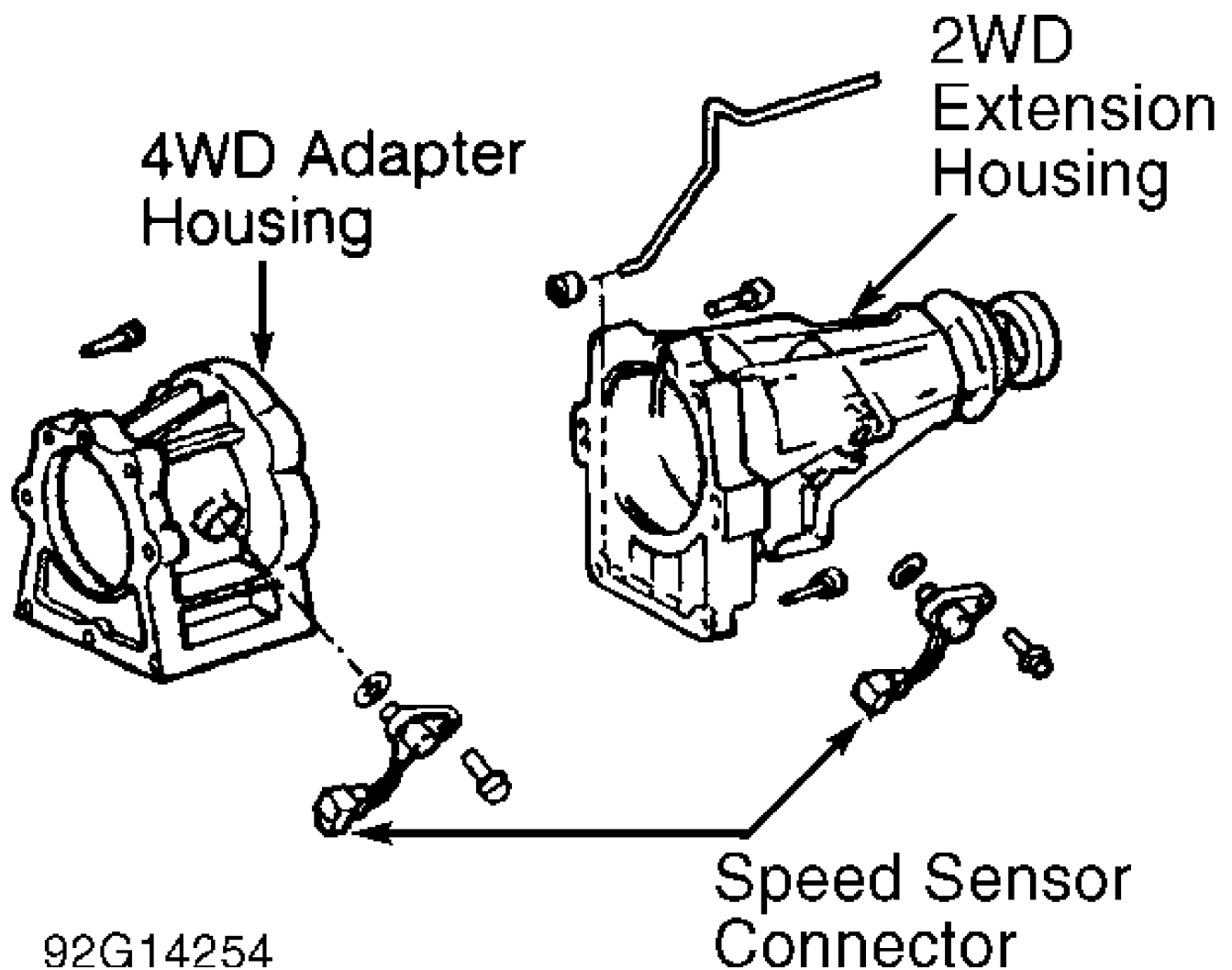


Fig. 122: Test 10A - Location of Speed Sensor Connector

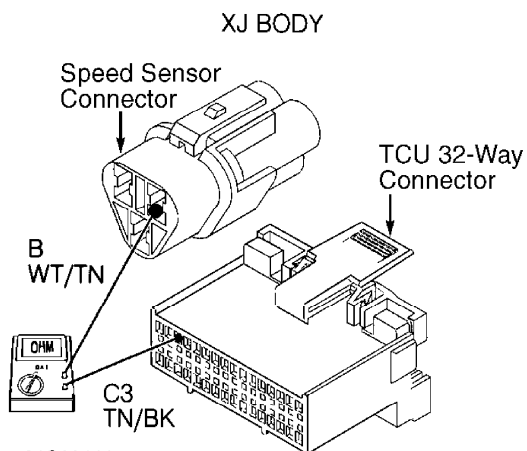


Fig. 123: Test 10A - Testing Speed Sensor (Cherokee)

## WIRING DIAGRAMS

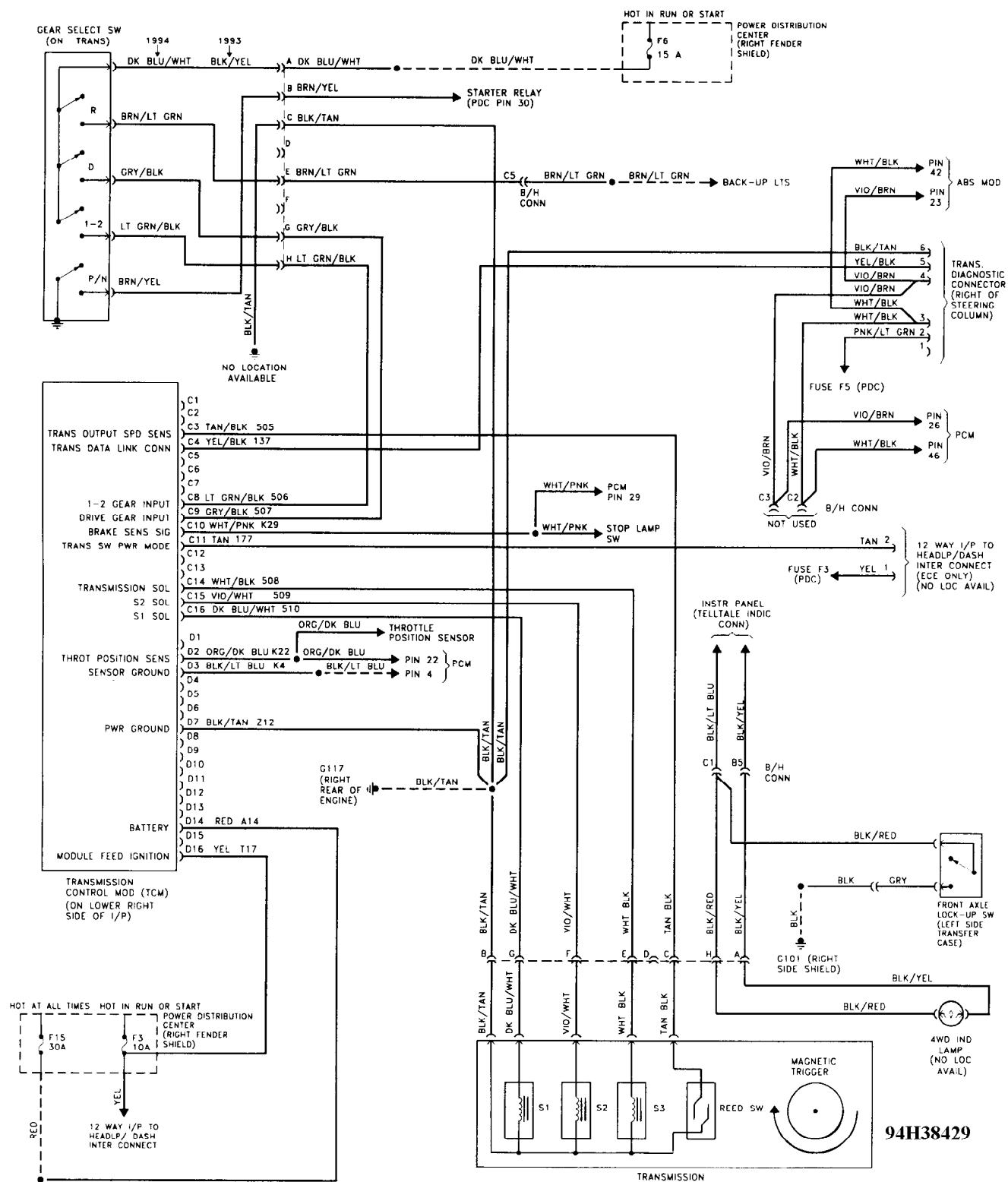
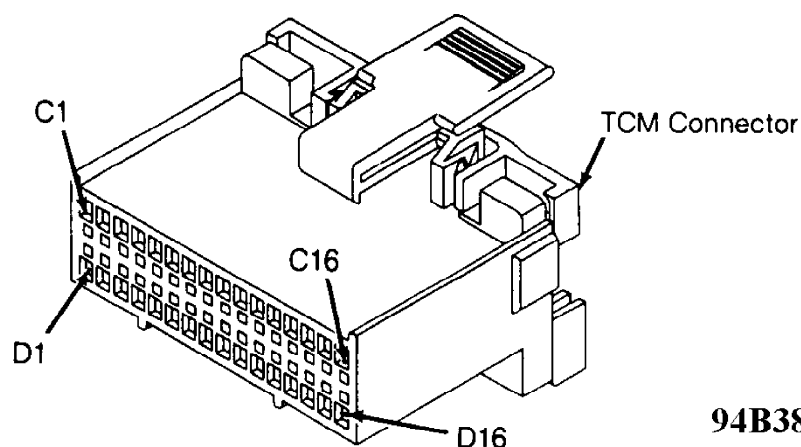


Fig. 124: Transmission Wiring Diagram (Cherokee)



94B38431

#### CHEROKEE

CAV ... CIRCUIT .....	FUNCTION
C1-C2 .....	Not Used
C3 .....	505 TN/BK..... Trans Speed Sensor
C4 .....	137 YL/BK ..... Auto Trans Diagnostic
C5-C7 .....	Not Used
C8 .....	506 LG/BK..... Low (1-2) Input
C9 .....	507 GY/BK ..... Drive (3) Input
C10 .....	K29 WT/PK .... Brake Input
C11 .....	Not Used
C12-C13 .....	Not Used
C14 .....	508 WT/BK..... S3 Solenoid (Converter Lockup)
C15 .....	509 VT/WT ..... S2 Solenoid
C16 .....	510 DB/WT ..... S1 Solenoid
D1 .....	Not Used
D2 .....	K22 OR/DB .... Throttle Position Sensor
D3 .....	K4 BK/LB..... TPS Signal Ground
D4-D6 .....	Not Used
D7 .....	Z12 BK/TN ..... Power Ground
D8-D13 .....	Not Used
D14 .....	A14 RD ..... Battery
D15 .....	Not Used
D16 .....	T17 YL ..... Ignition (Run/On)

#### GRAND CHEROKEE

CAV... CIRCUIT .....	FUNCTION
C1-C2 .....	Not Used
C3 .....	T14 LG/WT ..... Trans Speed Sensor
C4 .....	D82 BK/YL ..... Auto Trans Diagnostic
C5-C7 .....	Not Used
C8 .....	T25 LG..... Low (1-2) Input
C9 .....	T50 DG ..... Drive (3) Input
C10 ....	L53 BR..... Brake Input
C11-C13 .....	Not Used
C14 ....	T20 LB/BR ..... S3 Solenoid (Converter Lockup)
C15 ....	T59 PK..... S2 Solenoid
C16 ....	T60 BR/YL ..... S1 Solenoid
D1 .....	Not Used
D2 .....	K22 OR/DB .... Throttle Position Sensor
D3 .....	K4 BK/LB ..... TPS Signal Ground
D4-D6 .....	Not Used
D7 .....	Z1 BK..... Power Ground
D8-D13 .....	Not Used
D14 ....	A14 RD/WT ..... Battery
D15 .....	Not Used
D16 ....	F86 LB/RD ..... Ignition (Run/On)

Fig. 125: TCM Connector Terminals I.D., Circuits & Functions  
Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

### BRAKE SWITCH

#### Removal

Remove lower steering column cover or trim panels for access to brake switch (if necessary). Disconnect brake switch electrical connector. Thread brake switch from retainer and remove.

#### Installation

1) Install brake switch in retainer. Reconnect brake switch electrical connector.

2) To check brake switch adjustment, slightly depress brake pedal and note operation of brake switch plunger. Brake switch plunger should fully extend when brake pedal free play is taken up and brake application begins.

3) Clearance between brake switch plunger and brake pedal should be approximately 1/8". If clearance is not within specification, pull brake pedal rearward as far as possible.

4) Brake pedal should contact brake switch plunger, pushing brake switch backward in retainer to provide proper adjustment. Ensure brake lights operate.

5) Recheck clearance between brake switch plunger and brake pedal with brake pedal depressed and free play taken up. Reinstall lower steering column cover or trim panels.

### NEUTRAL SAFETY SWITCH

NOTE: Neutral safety switch may be referred to as park/neutral or gear select switch.

#### Removal

1) Apply parking brake. Raise and support vehicle. Disconnect electrical connector at neutral safety switch. Pry lock washer tabs away from retaining nut. See Fig. 126.

2) Remove retaining nut, lock washer and adjusting bolt. See Fig. 126. Remove neutral safety switch from manual valve shaft.

#### Installation

1) Disconnect shift control rod from transmission shift lever. Rotate transmission shift lever fully rearward and then forward 2 detents to Neutral position.

2) Install neutral safety switch on manual valve shaft. Install adjusting bolt but DO NOT tighten at this time.

3) Install lock washer and retaining nut. Tighten retaining nut to specification. See TORQUE SPECIFICATIONS. DO NOT bend over lock washer tabs at this time.

4) Ensure transmission is still in Neutral. Rotate neutral safety switch and align neutral standard line with vertical groove on manual valve shaft. See Fig. 126.

5) Tighten the adjusting bolt to specification. Refer to the TORQUE SPECIFICATIONS table. Bend lock washer tabs over. Reconnect shift control rod and electrical connector. Ensure vehicle starts in Park and Neutral only.

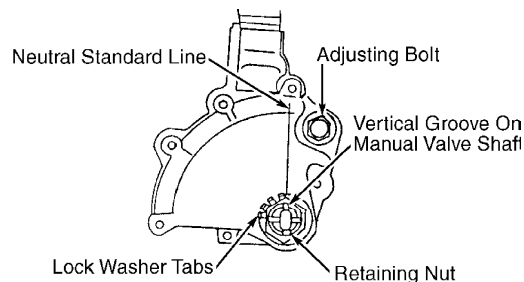


Fig. 126: Installing Neutral Safety Switch  
Courtesy of Chrysler Corp.

### SPEED SENSOR

#### Removal & Installation

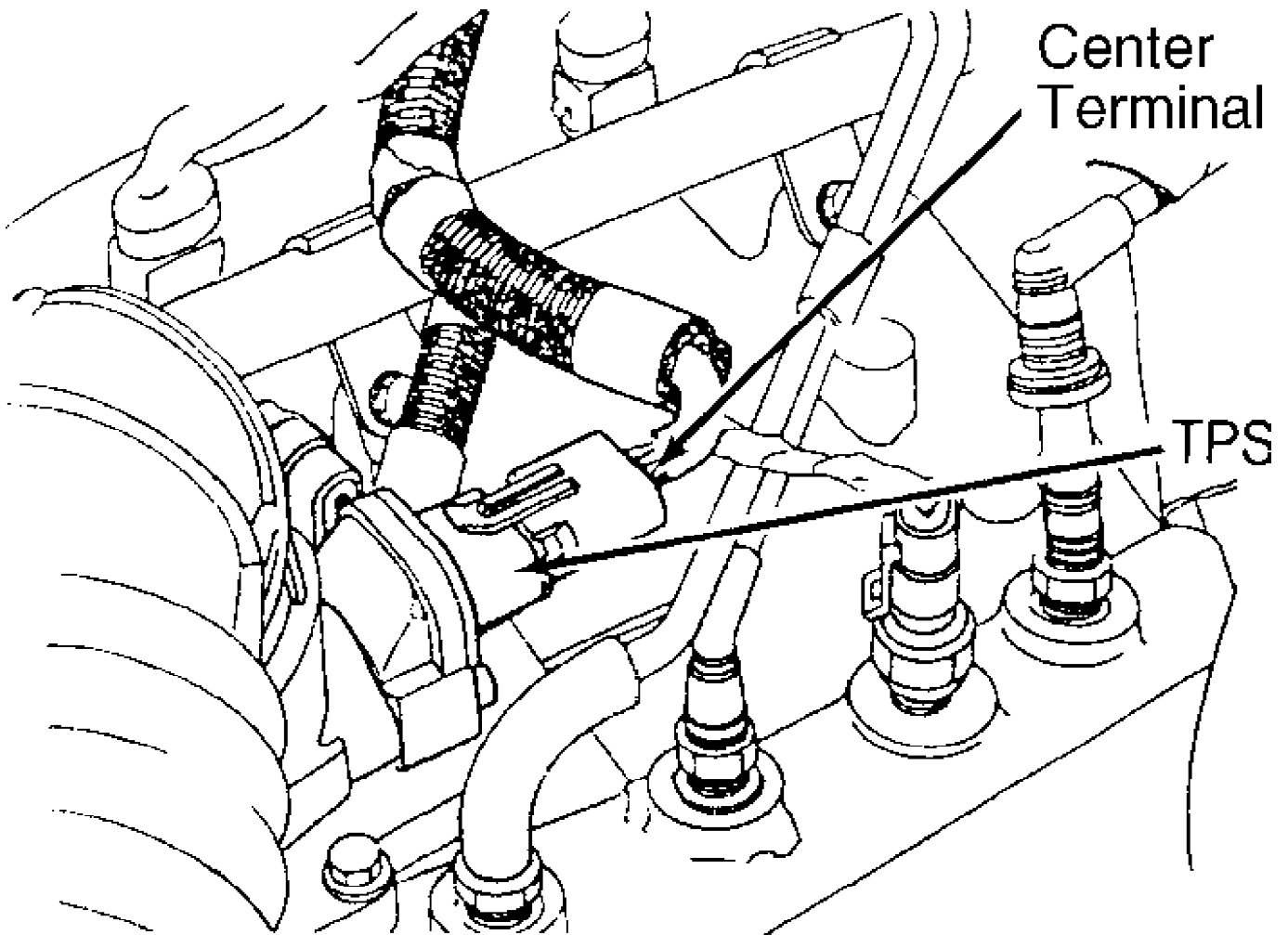
1) Disconnect electrical connector at speed sensor located on adapter housing or extension housing. Remove bolt and speed sensor. Remove "O" ring from speed sensor.

2) To install, reverse removal procedure using NEW "O" ring. Tighten bolt to specification. See TORQUE SPECIFICATIONS at end of article.

### THROTTLE POSITION SENSOR (TPS)

#### Removal & Installation

1) Note location of TPS electrical connector. See Fig. 127. Disconnect electrical connector. Remove screws and TPS.



**9213514**

Fig. 127: Identifying TPS Electrical Connector  
Courtesy of Chrysler Corp.

2) To install, reverse removal procedure. Ensure throttle shaft on throttle body engages socket tangs on TPS. See Fig. 128. Tighten screws. Manually operate throttle and ensure no binding exists. Reinstall electrical connector.

NOTE: TPS must be installed so it can be rotated a few degrees. If

TPS cannot be rotated, reinstall TPS with end of throttle shaft on other side of TPS socket tangs.

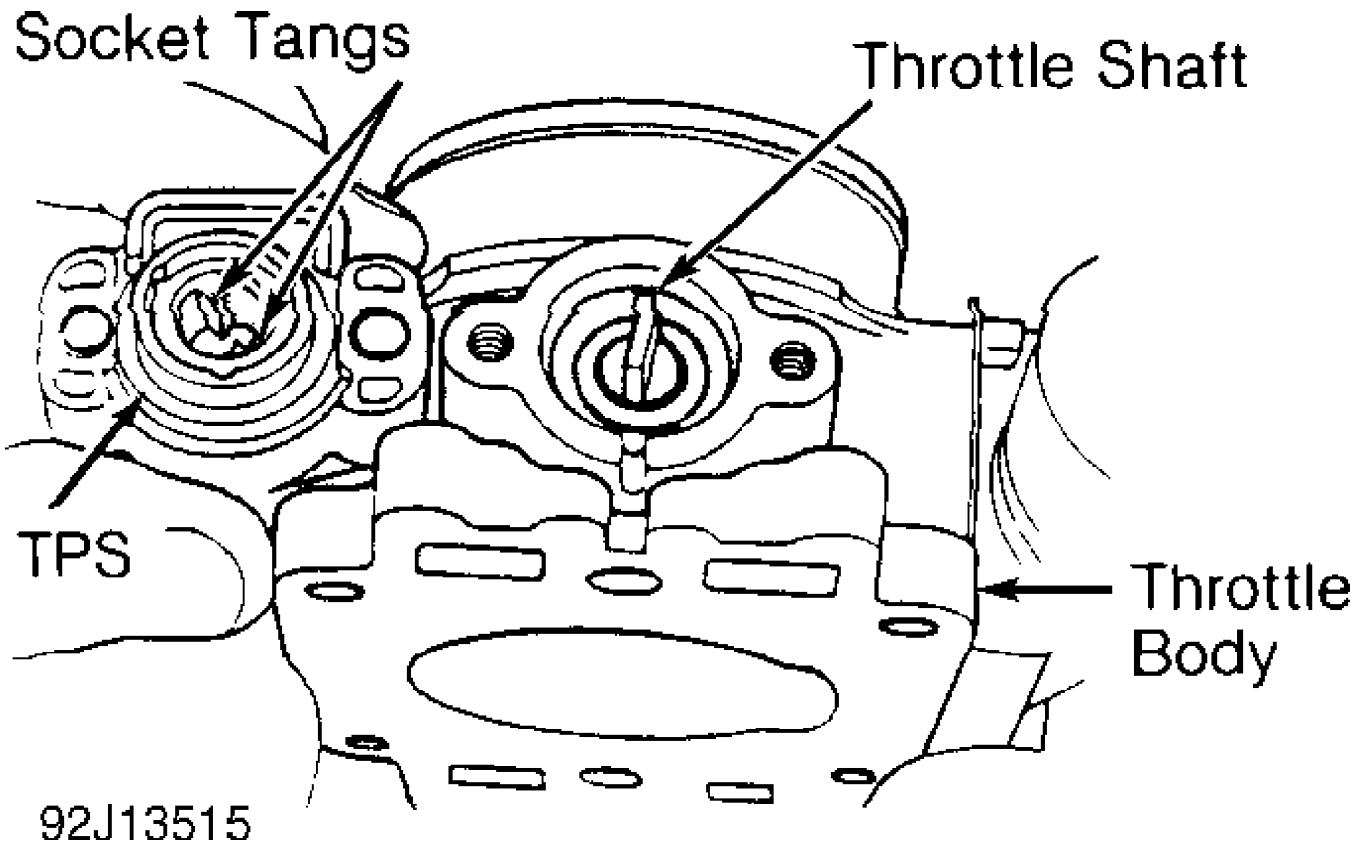


Fig. 128: Installing Throttle Position Sensor (TPS)  
Courtesy of Chrysler Corp.

#### TRANSMISSION CONTROL MODULE (TCM)

Removal & Installation (Cherokee)

Ensure ignition is off. Disconnect electrical connector from TCM, located behind right side of instrument panel. See Fig. 129. Remove fastener and TCM from instrument panel. To install, reverse removal procedure.

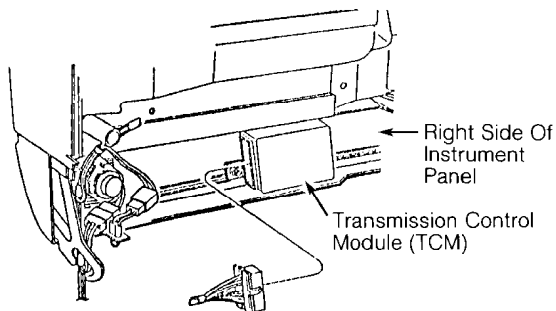


Fig. 129: Transmission Control Module (TCM) I.D. (Cherokee)  
Courtesy of Chrysler Corp.

#### VALVE BODY SOLENOID

#### Removal

1) Raise and support vehicle. Remove drain plug and drain transmission fluid. Remove bolts and oil pan. Remove bolts, oil screen and gasket.

2) Disconnect electrical connectors from valve body solenoid. Mark electrical connector location for reassembly reference if more than one valve body solenoid is being removed. Remove bolt, valve body solenoid and "O" ring.

CAUTION: DO NOT allow components to fall from valve body when removing valve body solenoid.

#### Installation

1) To install, reverse removal procedure using NEW "O" ring and NEW gaskets. Tighten valve body solenoid bolt and oil screen bolt to specification. See TORQUE SPECIFICATIONS at end of article.

2) Ensure magnet is installed in oil pan and does not interfere with valve body oil tubes. Apply 1/8" bead of Loctite 599 sealant on oil pan mounting flange. Install oil pan. Install and tighten bolts to specification. See TORQUE SPECIFICATIONS.

3) Install NEW gasket and drain plug. Tighten drain plug to specification. See TORQUE SPECIFICATIONS at end of article. Fill transmission to proper fluid level with Mopar Dexron-IIIE/Mercon ATF.

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS

---

Application	Ft. Lbs. (N.m)
-------------	----------------

Drain Plug .....	15 (20)
------------------	---------

INCH Lbs. (N.m)

Neutral Safety Switch Adjusting Bolt .....	108 (12.2)
Neutral Safety Switch Retaining Nut .....	61 (6.9)
Oil Pan Bolt .....	65 (7.3)
Oil Screen Bolt .....	84 (9.5)
Speed Sensor Bolt .....	65 (7.3)
Valve Body Solenoid Bolt .....	84 (9.5)

---



## B - EMISSION APPLICATION

### 1993 Jeep Cherokee

1993 ENGINE PERFORMANCE

Chrysler Motors Emission Applications

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### EMISSION APPLICATIONS

#### EMISSION CONTROL APPLICATIONS TABLE

Engine & Fuel System	Emission Control Systems & Devices
2.5L (150") MPI & 4.0L (242") MPI	
Major Emission Control Systems .....	(1) CCV, EVAP, TWC, SPK, O2, CEC, SRI, MIL
Components & Other Related Devices .....	EVAP-CPCV, EVAP-PRRV, EVAP-VC, SPK-CC, SPK-TCS,
5.2L (318") MPI	
Major Emission Control Systems .....	PCV, EVAP, TWC, (2) BP/EGR, SPK, O2, CEC, SRI, MIL
Components & Other Related Devices .....	EVAP-CPCS, EVAP-VC, EVAP-PRRV, BP/EGR-EET, SPK-CC

(1) - No PCV valve is used.

(2) - Electronic-controlled.

### ABBREVIATION DEFINITIONS

#### ABBREVIATION DEFINITIONS TABLE

Abbreviation	Definition
BP/EGR .....	Backpressure EGR
BP/EGR-EET .....	BP/EGR Electronic EGR Transducer
CCV .....	Crankcase Ventilation
CEC .....	Computerized Engine Control
EVAP .....	Evaporative Emission Control
EVAP-CPCS .....	EVAP Canister Purge Control Solenoid
EVAP-CPCV .....	Canister Purge Control Valve
EVAP-PRRV .....	Pressure Relief/Rollover Valve
EVAP-VC .....	EVAP System Vapor Canister
MIL .....	Malfunction Indicator Light
MPI .....	Multi-Point Fuel Injection
O2 .....	Oxygen Sensor
PCV .....	Positive Crankcase Ventilation
SPK .....	Spark Controls
SPK-CC .....	SPK Computer Controlled
SPK-TCS .....	SPK Transmission Controlled
SRI .....	Service Reminder Indicator Light
TWC .....	Three-Way Catalyst

# BRAKE SYSTEM

## 1993 Jeep Cherokee

1993 BRAKES

Chrysler Corp. - Disc & Drum

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION

Floating caliper disc brake assembly uses a single piston caliper which floats on 2 bolts. As brake pedal is depressed, hydraulic pressure passes through a proportioning valve to brake caliper piston.

This force is transmitted to inboard brake pad, forcing it against braking surface of rotor. Pressure then moves outer caliper housing and pad inward on caliper mounting bolts, forcing outer pad against outer braking surface of rotor.

A combination proportioning valve/pressure differential switch is used on all models. Proportioning valve is not serviceable. Valve must be replaced if it malfunctions.

A pressure differential brake warning light switch is used to warn vehicle operator that one side of the hydraulic system has failed. When hydraulic pressure is equal in both front and rear systems, switch piston remains centered and does not contact terminal in switch. If one side of brake system fails, hydraulic pressure moves piston toward failed side. Shoulder of piston contacts switch terminal, grounding brake warning light.

Proportioning valve operates by restricting hydraulic pressure to rear brakes at a given ratio when system hydraulic pressure reaches a certain point. This improves front-to-rear brake balance during high speed braking, when a percentage of rear weight is transferred to front wheels. Valve reduces rear brake pressure and delays rear wheel skid. On light brake application, valve allows full hydraulic pressure to rear brakes.

### BLEEDING BRAKE SYSTEM

NOTE: Brake bleeding procedures for models with anti-lock brakes are not covered in this article. See ANTI-LOCK BRAKE SYSTEM article for proper procedure.

### BLEEDING SEQUENCE

Before bleeding system, exhaust all vacuum from power unit by depressing brake pedal several times. When bleeding disc brakes, air may tend to cling to caliper walls. To aid in removal of air, lightly tap caliper while bleeding.

Fill master cylinder with clean brake fluid. Fluid should meet DOT 3 specifications. Bleed master cylinder with bleeder valves (if equipped). Bleed wheel cylinders and calipers in sequence. See BRAKELINE BLEEDING SEQUENCE table.

BRAKELINE BLEEDING SEQUENCE TABLE

Application	Sequence
All Models .....	RR, LR, RF, LF

### MASTER CYLINDER BLEEDING

#### Bench Bleeding

1) Master cylinder must be bled before installation to prevent excessive amounts of air from entering hydraulic system, creating poor brake operation.

2) Place master cylinder in soft-jawed vise. DO NOT tighten vise enough to damage master cylinder. Install bleed tubes in both outlets of master cylinder. See Fig. 1.

3) Fill master cylinder with clean brake fluid. Fluid should meet DOT 3 specifications. Ensure end of bleed tubes are submerged in brake fluid.

4) Using proper size rod, apply and release master cylinder until no air bubbles exist in brake fluid flow. When all air bubbles are gone from master cylinder, cap outlet ports. Install reservoir cover and seal. Install master cylinder and bleed on vehicle.

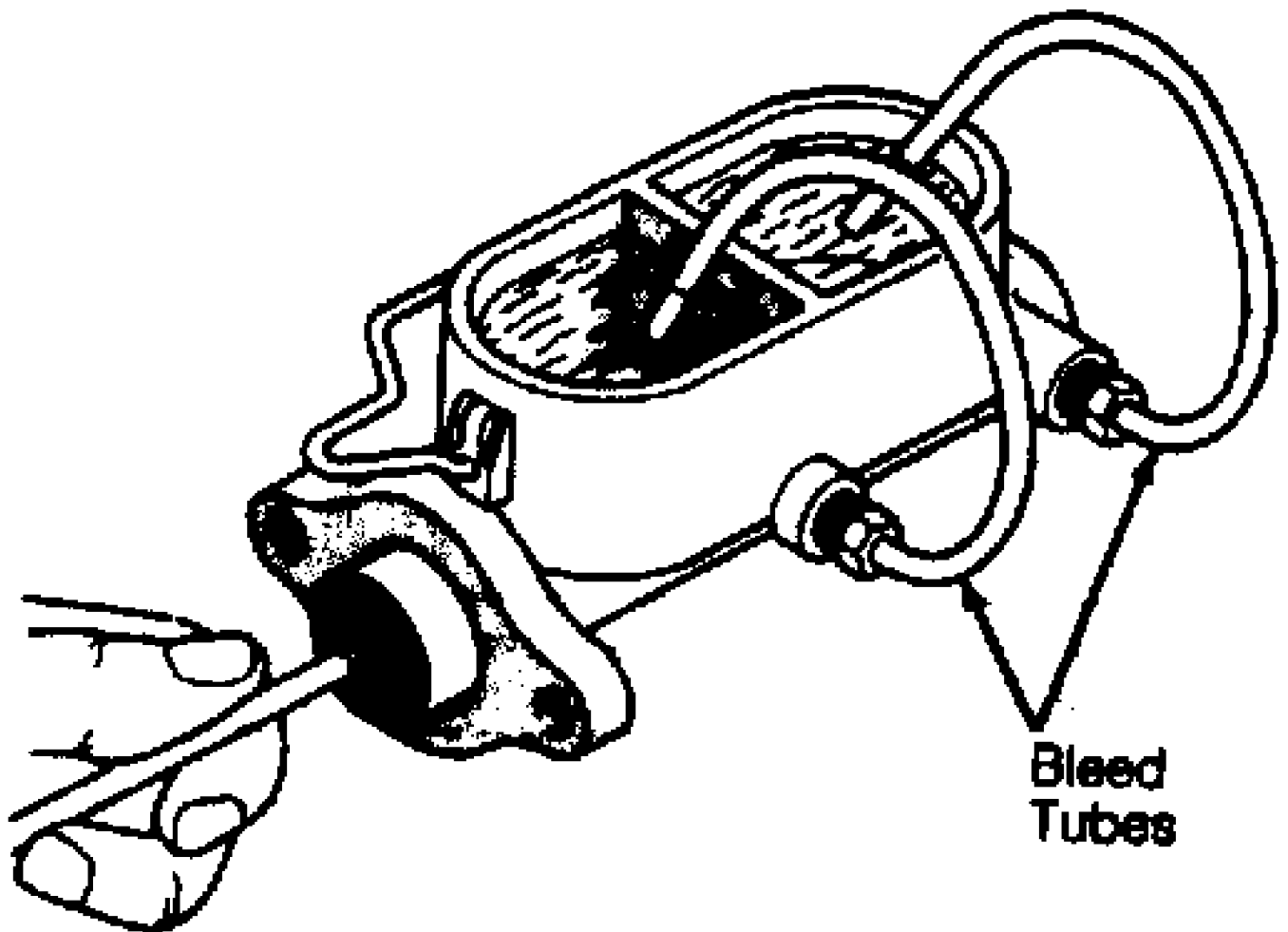


Fig. 1: Bleeding Master Cylinder (Typical)  
Courtesy of Chrysler Motors.

#### On-Vehicle Bleeding

1) Install master cylinder on vehicle after bench bleeding. Remove bleeder lines and install brakelines. DO NOT tighten brakelines yet.

2) Slowly force brake pedal to floor and hold in this position. Tighten brakelines, and release brake pedal. Repeat procedure until no air bubbles exist at brakelines. Tighten

brakelines. Check for leaks.

## PRESSURE BLEEDING

**CAUTION:** Front brake metering valve is located in front end of combination valve. Valve stem **MUST** be pressed inward or held outward slightly to bleed front brakes.

1) Clean master cylinder cap and surrounding area. Remove cap. With pressure tank at least 1/2 full, connect to master cylinder with adapters. Attach bleed hose to first bleeder valve to be serviced. See BRAKELINE BLEEDING SEQUENCE table under BLEEDING SEQUENCE.

2) Place other end of hose in clean glass jar partially filled with clean brake fluid so end of hose is submerged in fluid.

3) Open release valve on pressure bleeder. Follow equipment manufacturer's pressure instructions or see PRESSURE BLEEDER SETTINGS table. Open bleeder valve 3/4 turn, and note fluid flow.

4) Close bleeder screw when fluid is free of bubbles. Repeat procedure on remaining wheels in proper sequence. Check brake pedal operation after bleeding has been completed.

5) Remove pressure bleeding equipment and valve retainer from hold-off valve. Ensure master cylinder is full of fluid. Check for leaks.

### PRESSURE BLEEDER SETTINGS TABLE

Application	psi (kg/cm <sup>2</sup> )
All Models .....	15-20 (1.1-1.4)

## MANUAL BLEEDING

**NOTE:** Some models are equipped with anti-lock brake system. See ANTI-LOCK BRAKE SYSTEM article for bleeding procedure.

Cherokee & Wrangler

1) Fill master cylinder with clean brake fluid. Fluid should meet DOT 3 specifications. Open ALL bleed valves. Close bleeder valves when fluid begins flowing from each valve. Refill master cylinder.

2) Install bleed hose to first bleeder valve to be serviced. See BRAKELINE BLEEDING SEQUENCE table under BLEEDING SEQUENCE. Submerge other end of hose in clean glass jar partially filled with clean brake fluid. See Fig. 2.

**NOTE:** Ensure bleeder valve is closed when brake pedal is released. DO NOT allow master cylinder to run out of fluid.

3) Open bleeder valve 3/4 turn. Depress brake pedal slowly through full travel. Close bleeder valve, and release pedal. Repeat procedure until flow of fluid shows no signs of air bubbles.

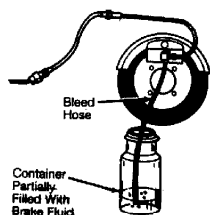


Fig. 2: Bleeding Brakes (Manual Procedure)  
Courtesy of Chrysler Motors.

## ADJUSTMENTS

### BRAKE PEDAL

Brake pedal push rod length is preset by manufacturer. No adjustment is possible.

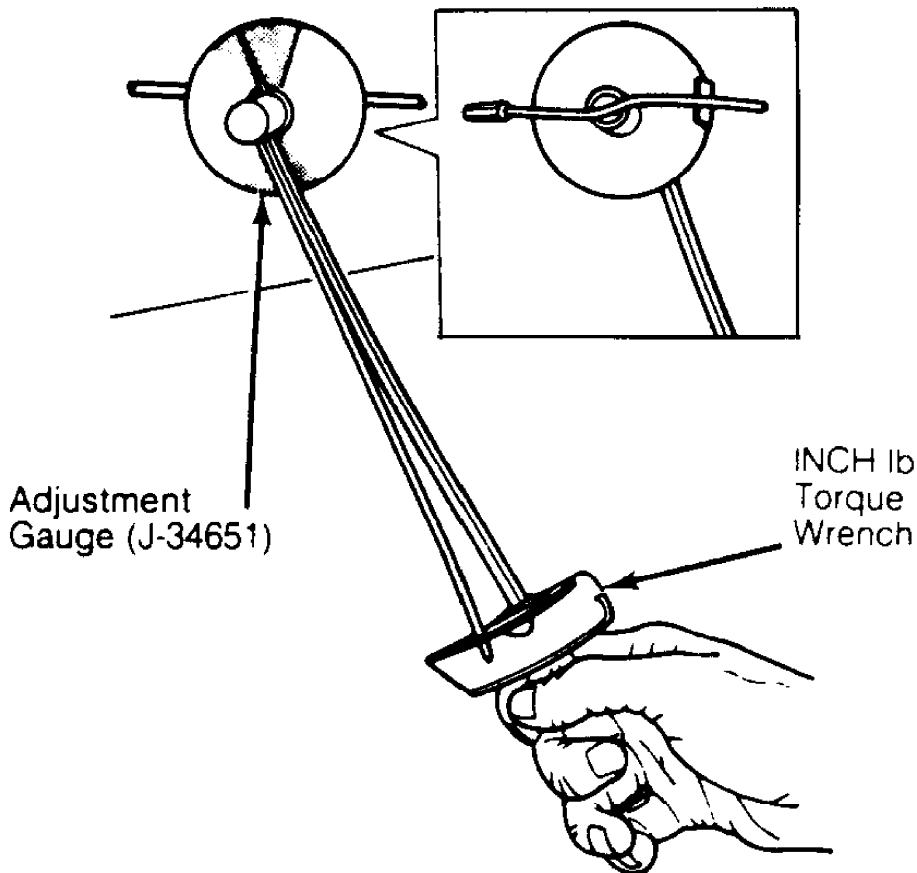
### PARKING/EMERGENCY BRAKE

Cherokee & Wrangler

1) Adjust rear brakes. See REAR BRAKE SHOES under ADJUSTMENTS . Check cable for binding, kinking or fraying. Replace cable as required. Apply and release parking brake 5 times.

2) Place parking brake lever in fifth notch. Raise and support vehicle. Position Adjustment Gauge (J-34651) on one of rear parking brake cables. See Fig. 3. Apply and hold a torque of 50 INCH lbs. (6 N.m) on adjustment gauge, and note position of gauge pointer.

3) If adjustment gauge pointer is not within okay band, turn parking brake cable equalizer adjustment nut in or out until pointer is within okay band. Remove tools, and lower vehicle. Ensure proper parking brake operation.



30086

Fig. 3: Adjusting Parking Brake (Cherokee & Wrangler)  
Courtesy of Chrysler Motors.

Grand Cherokee & Grand Wagoneer

1) Adjust rear brakes. See REAR BRAKE SHOES under ADJUSTMENTS

. Check cable for binding, kinking or fraying. Replace cable as required.

2) Fully apply parking brake. Raise and support vehicle. Mark position of adjusting nut on threaded end of cable tensioner. Tighten adjusting nut about 1/2" (13 mm). Replace tensioner if there are not enough threads for proper adjustment.

3) Lower vehicle until wheels are about 6" off floor. Release parking brake. Verify that rear wheels rotate freely and no drag is felt. Lower vehicle, and ensure parking brake operates properly.

## REAR BRAKE SHOES

**NOTE:** Brakes are self-adjusting. Under normal circumstances, manual adjustment is only required if shoes are removed. Replace brake shoes when lining is 1/16" on bonded linings and 1/32" from rivet on riveted linings.

1) Raise and support vehicle. Remove wheels and brake drums. Ensure right and left automatic adjuster lever and cable are properly connected.

2) Insert Brake Shoe Adjustment Gauge (J-21177-01) in drum. See Fig. 4. Expand gauge until inner legs contact drum braking surface. Lock gauge in position.

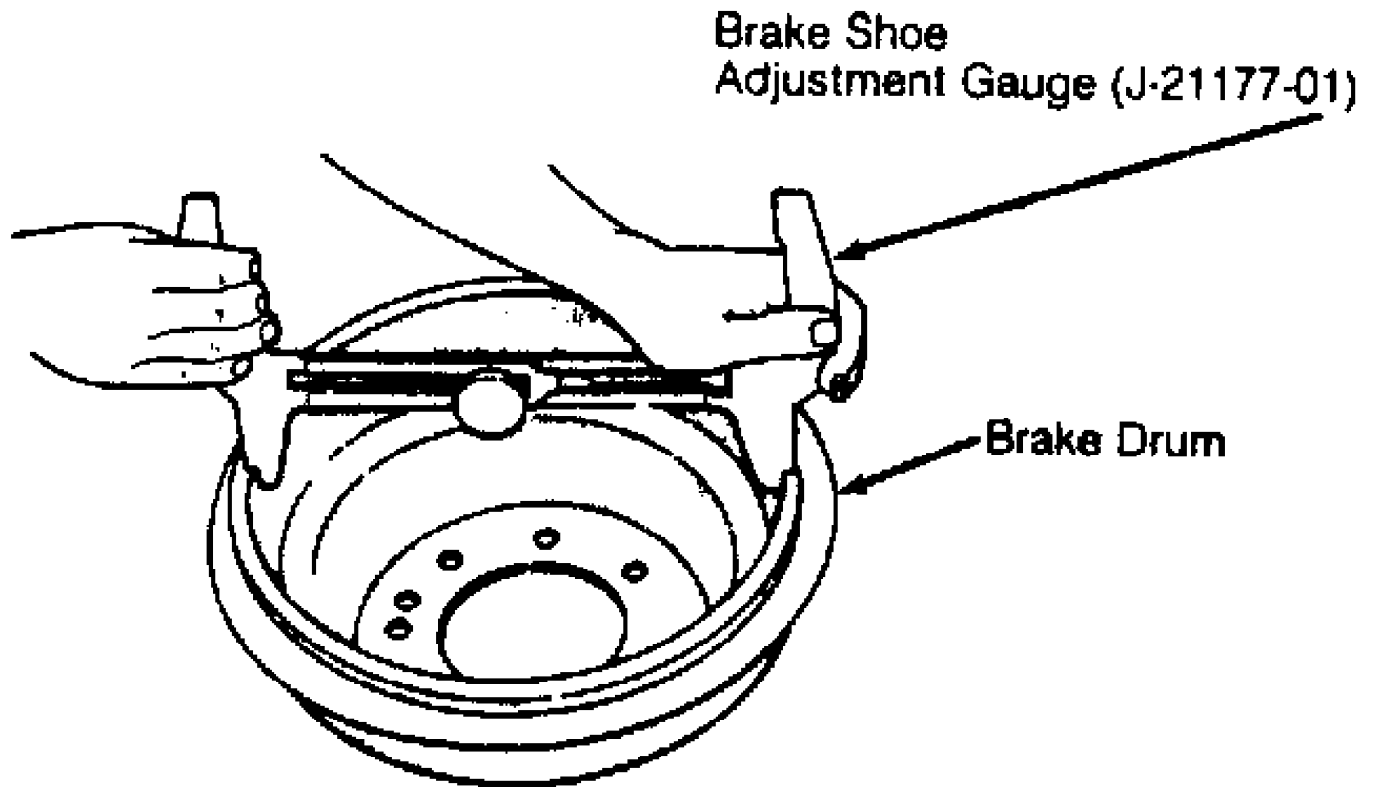


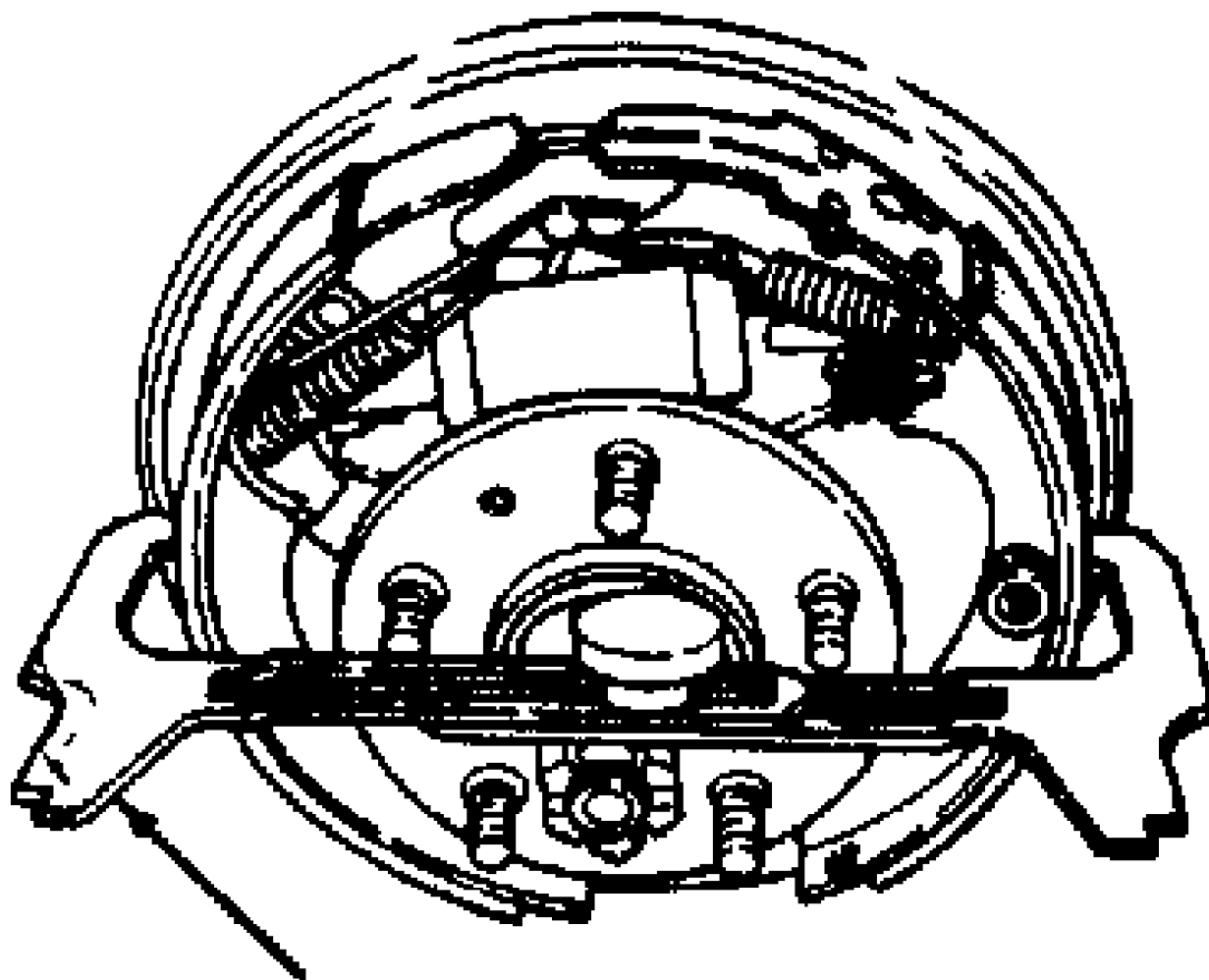
Fig. 4: Measuring Brake Drum Diameter  
Courtesy of Chrysler Motors.

3) Reverse brake shoe adjustment gauge, and install it on brake shoes. See Fig. 5. Position gauge legs at shoe centers. If gauge does not fit (too loose or too tight), adjust brake shoes accordingly.

4) Turn star adjuster wheel (by hand) to expand or retract brake shoes. Continue adjustment until gauge outside legs have a slight drag on shoes. Repeat procedure on opposite brake shoe

assembly.

5) Install brake drum and wheels. Lower vehicle. Make final adjustment by driving vehicle and making one forward stop (complete stop), followed by one reverse stop (complete stop). Repeat procedure 8-10 times to operate automatic adjusters and equalize adjustment.



## **Brake Shoe Adjustment Gauge (J-21177-01)**

Fig. 5: Measuring Brake Shoe Diameter  
Courtesy of Chrysler Motors.

### **STOPLIGHT SWITCH**

Move brake pedal forward by hand until free play is taken up. If clearance between stoplight switch plunger and brake pedal is  $\frac{1}{8}$ " (3 mm) and stoplight functions properly, no adjustment is needed. If adjustment is necessary, press brake pedal forward by hand. Push stoplight switch forward in mounting bracket as far as possible. Grasp brake pedal and pull rearward to stop and release. Recheck clearance and stoplight operation.

## TESTING

### POWER BOOSTER

#### Master Cylinder/Power Booster

1) Start engine, and check power booster vacuum hose for leaks. Repair as required. Stop engine, and place gear selector in Neutral. Pump brake pedal until all vacuum reserve is depleted.

2) Press and hold brake pedal under light foot pressure. If pedal does not hold firm and falls away, master cylinder is leaking internally. Repair or replace as required. If brake pedal holds firm, proceed to next step.

3) While holding light pressure on pedal, start engine, and note pedal action. If no pedal action is noticeable, power booster or vacuum check valve is faulty. Replace check valve, and repeat test. If pedal falls away slightly then holds firm, proceed to next step.

4) Release brake pedal. Increase engine speed to 1500 RPM, close throttle and immediately stop engine. Wait at least 90 seconds and retest pedal action. Booster should provide 2 or more vacuum assisted pedal applications. If pedal action is not as specified, perform CHECK VALVE & POWER BOOSTER VACUUM test.

#### Check Valve & Power Booster Vacuum

1) Disconnect vacuum hose from check valve. Remove check valve and seal from booster. Using a hand-held vacuum pump, apply 15-20 in. Hg at large end of check valve. If gauge on pump indicates any vacuum loss, valve is faulty and must be replaced. If gauge holds steadily, proceed to next step.

2) Reinstall check valve and seal into power booster. Tee a vacuum gauge into vacuum hose between power booster and vacuum source. Start engine, and let idle one minute. Clamp hose shut between vacuum source and power booster.

3) Stop engine, and observe vacuum gauge. If vacuum drops more than one in. Hg within 15 seconds, booster diaphragm or check valve is faulty. Replace as required.

### BRAKE WARNING LIGHT SYSTEM

#### Electrical Circuit

Disconnect wire from switch terminal, and ground wire to chassis. Turn ignition on. Warning light should come on. If light does not operate, bulb or wiring circuit is defective. Replace bulb or repair wiring as necessary. If light illuminates, turn off ignition, and connect wire.

#### Warning Light Switch

1) Attach a bleeder hose to bleeder valve at either rear brake. Immerse other end of hose in container with brake fluid. Turn ignition on.

2) Open bleeder valve while pressure is being applied to brake pedal. Warning light should activate. Close bleeder valve before pressure is released from pedal.

3) Reapply brake pedal using moderate to heavy pressure. Light should go out. Repeat test on front brake system. System should function in same manner. Turn ignition off.

4) If light does not operate as specified for either system but comes on when electrical circuit is tested, warning light switch portion of valve is defective.

## REMOVAL & INSTALLATION



## FRONT BRAKE CALIPER & BRAKE PADS

NOTE: Replace brake pads when lining is 1/32" (.8 mm) from rivet heads.

### Removal

1) Drain about half of brake fluid from master cylinder reservoir. Raise and support vehicle. Remove front wheels.

2) Place "C" clamp on caliper. Solid end of clamp should contact back of caliper. Screw end should contact metal part of outboard pad. Tighten "C" clamp until piston is forced to bottom of bore.

3) On 4WD models, do not allow "C" clamp screw to bear directly on outboard shoe retainer spring. If necessary, use wood or metal spacer between pad and "C" clamp screw.

4) On all models, remove caliper mounting pins. Lift caliper off rotor and anchor plate. On 4WD models, brake pads will remain attached to caliper. On 2WD models, brake pads will remain on caliper support.

5) On 4WD models, remove outboard pad. Press one end of outboard pad inward to disengage pad lug, and rotate shoe outward until retainer spring clears caliper. Press opposite end of pad inward to disengage opposite pad lug, and rotate pad up and out of caliper. To remove inboard pad, grasp ends of pad, and tilt pad outward to release springs from caliper piston. Remove pad from piston.

6) On 2WD models, hold lower anti-rattle clip against support bracket and remove outboard brake pad from caliper support. Remove inboard brake pad and both anti-rattle clips from caliper support.

7) On all models, disconnect brakeline at caliper, and cap hole to prevent contamination while removing caliper from vehicle.

### Installation

1) To install, reverse removal procedure. Apply a light coat of multipurpose grease to caliper sliding surfaces. Lubricate caliper mounting pins and bushings with silicone.

2) Torque caliper mounting pins to specification. See, at the end of this article, TORQUE SPECIFICATIONS. Add brake fluid to reservoir. Apply brakes until brake pedal is firm. Check brake fluid level.

## ROTOR

NOTE: DO NOT disconnect brake hose from caliper unless caliper is to be disassembled.

### Removal (2WD)

1) Raise and support vehicle. Remove front wheels. Remove caliper. See FRONT BRAKE CALIPER & BRAKE PADS under REMOVAL & INSTALLATION. Suspend caliper from frame or suspension with wire.

2) Remove cap, cotter pin, nut retainer, adjusting nut and front bearing from spindle. Remove rotor from spindle. Remove grease seal and rear bearing from hub.

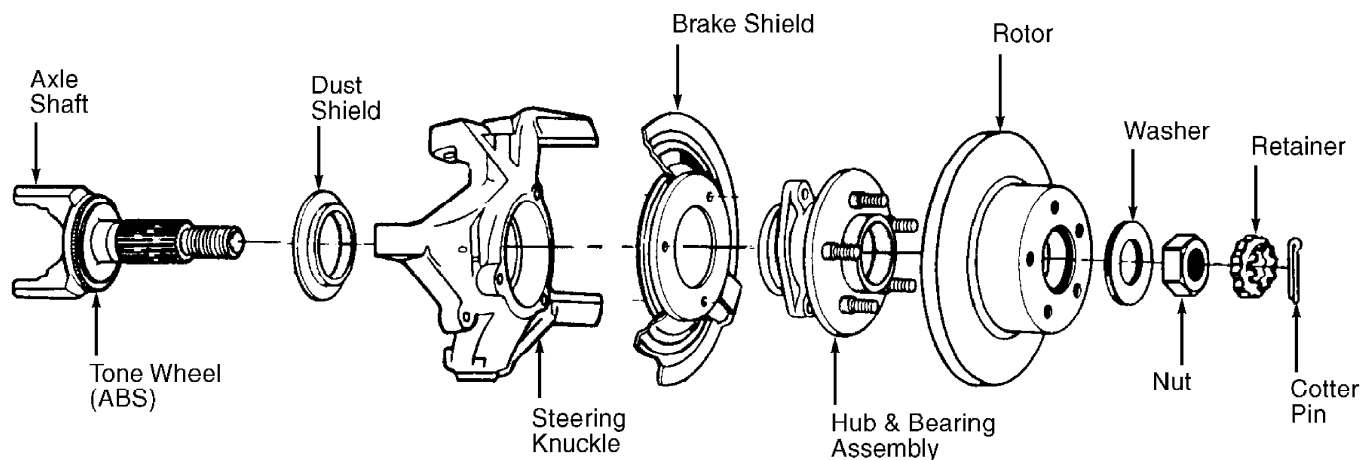
### Installation (2WD)

1) Clean, inspect and repack wheel bearings. Replace grease seal. Coat spindle, bearing races and rotor hub cavity with grease. Clean rotor surface as required.

2) To install, reverse removal procedure. Tighten spindle nut to specification while rotating rotor to seat bearings. See, at the end of this article, TORQUE SPECIFICATIONS. Apply brakes until brake pedal is firm. Check brake fluid level.

### Removal & Installation (4WD)

Raise and support vehicle. Remove front wheels. Remove caliper. See, under REMOVAL & INSTALLATION, FRONT BRAKE CALIPER & BRAKE PADS. Suspend caliper from frame or suspension. Remove retainers securing rotor to hub. Remove rotor from hub. To install, reverse removal procedure. See Fig. 6.



92D21835

Fig. 6: Exploded View Of Rotor & Hub Assembly  
Courtesy of Chrysler Motors.

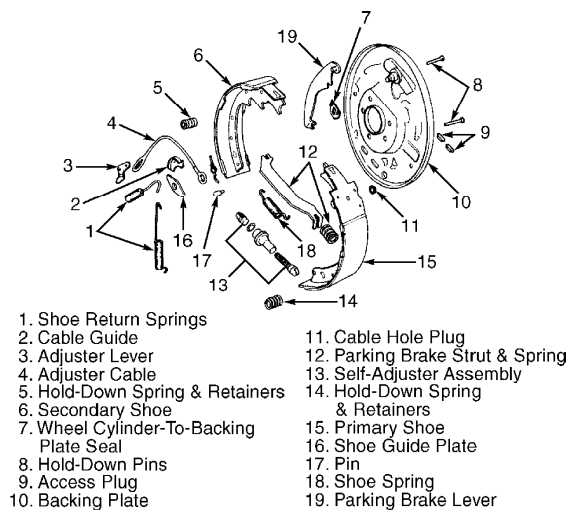
## REAR BRAKE SHOES

### Removal

1) Raise and support vehicle. Remove wheels and brake drum. Remove "U" clip and washer from parking brake lever pivot pin. Place Wheel Cylinder Clamp (J-8002) over wheel cylinder.

2) Remove primary and secondary shoe return springs, hold-down spring and retainers and pins. See Fig. 7 or 8. Remove self-adjuster lever, adjuster and adjuster spring from brake shoes.

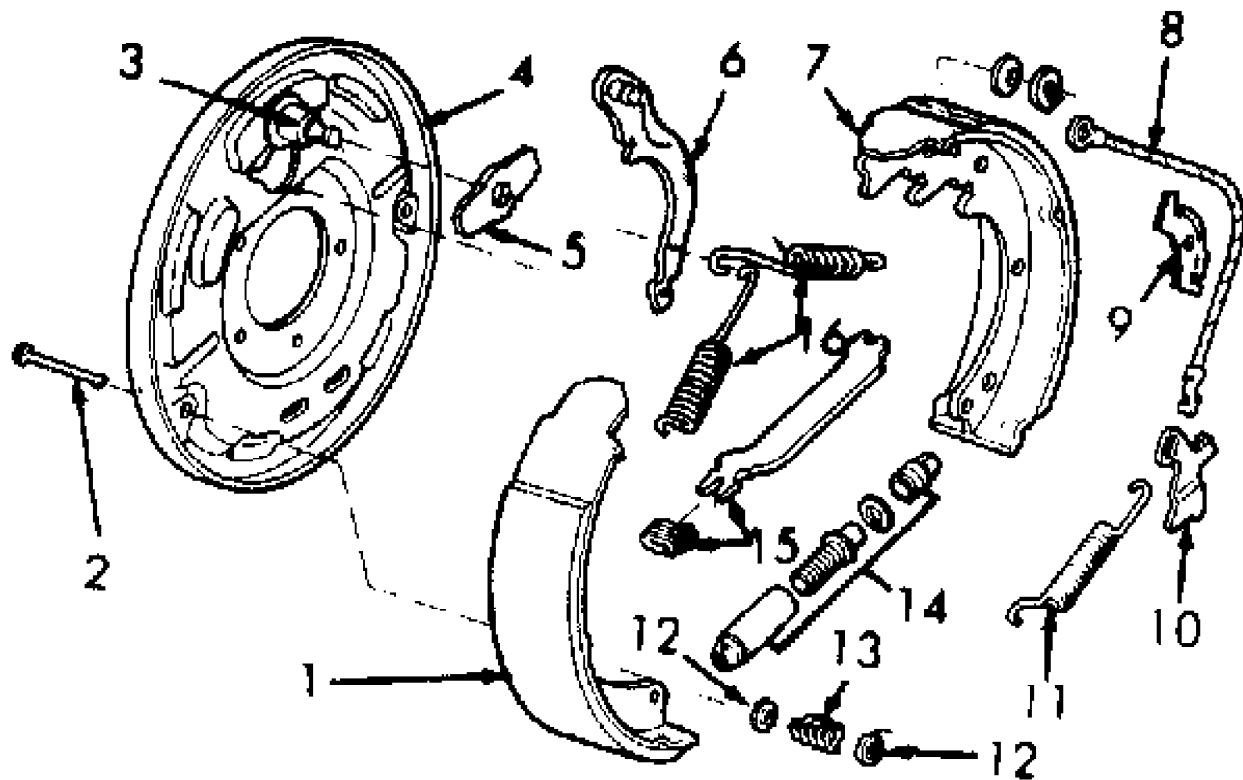
3) Remove brake shoes. Disconnect parking brake cable from parking brake lever, and remove lever.



90J15338

Fig. 7: Rear Drum Brake Assembly (Cherokee & Wrangler)  
Courtesy of Chrysler Motors.

## LEFT REAR BRAKE ASSEMBLY



- |                        |                             |
|------------------------|-----------------------------|
| 1. Primary Shoe        | 9. Cable Guide              |
| 2. Hold-Down Pin       | 10. Adjuster Lever          |
| 3. Anchor Pin          | 11. Shoe Spring             |
| 4. Backing Plate       | 12. Spring Retainers        |
| 5. Shoe Guide Plate    | 13. Hold-Down Spring        |
| 6. Parking Brake Lever | 14. Adjuster Screw Assembly |
| 7. Secondary Shoe      | 15. Strut & Spring          |
| 8. Adjuster Cable      | 16. Return Springs          |

Fig. 8: Rear Drum Brake Assembly (Grand Cherokee & Grand Wagoneer)  
Courtesy of Chrysler Motors.

### Installation

1) Lubricate backing plate ledges, anchor pin, cable guide, self-adjuster screw assembly, parking brake lever and lever pivot pin with White lithium grease. See Fig. 7 or 8.

2) Connect parking brake lever to secondary brake shoe with washer and "U" clip. Crimp ends of clip to secure clip on pivot. Remove wheel cylinder clamp. Position brake shoes on brake support plate, and install hold-down springs.

3) Install parking brake lever strut and spring. Install cable guide plate and adjuster cable on anchor pin. Install primary return spring. Install guide to secondary brake shoe. Install secondary return spring.

4) Install adjuster screw, spring and lever. Connect lever to

cable. Using Brake Shoe Adjustment Gauge (J-21177-01), preset brake shoe adjustment. See REAR BRAKE SHOES under ADJUSTMENTS. Install brake drums. Install wheels, and lower vehicle. Check brake fluid. Road test vehicle.

## OVERHAUL

NOTE: For overhaul, refer to appropriate illustration for exploded view of component. See Fig. 9 or 10.

## CALIPER

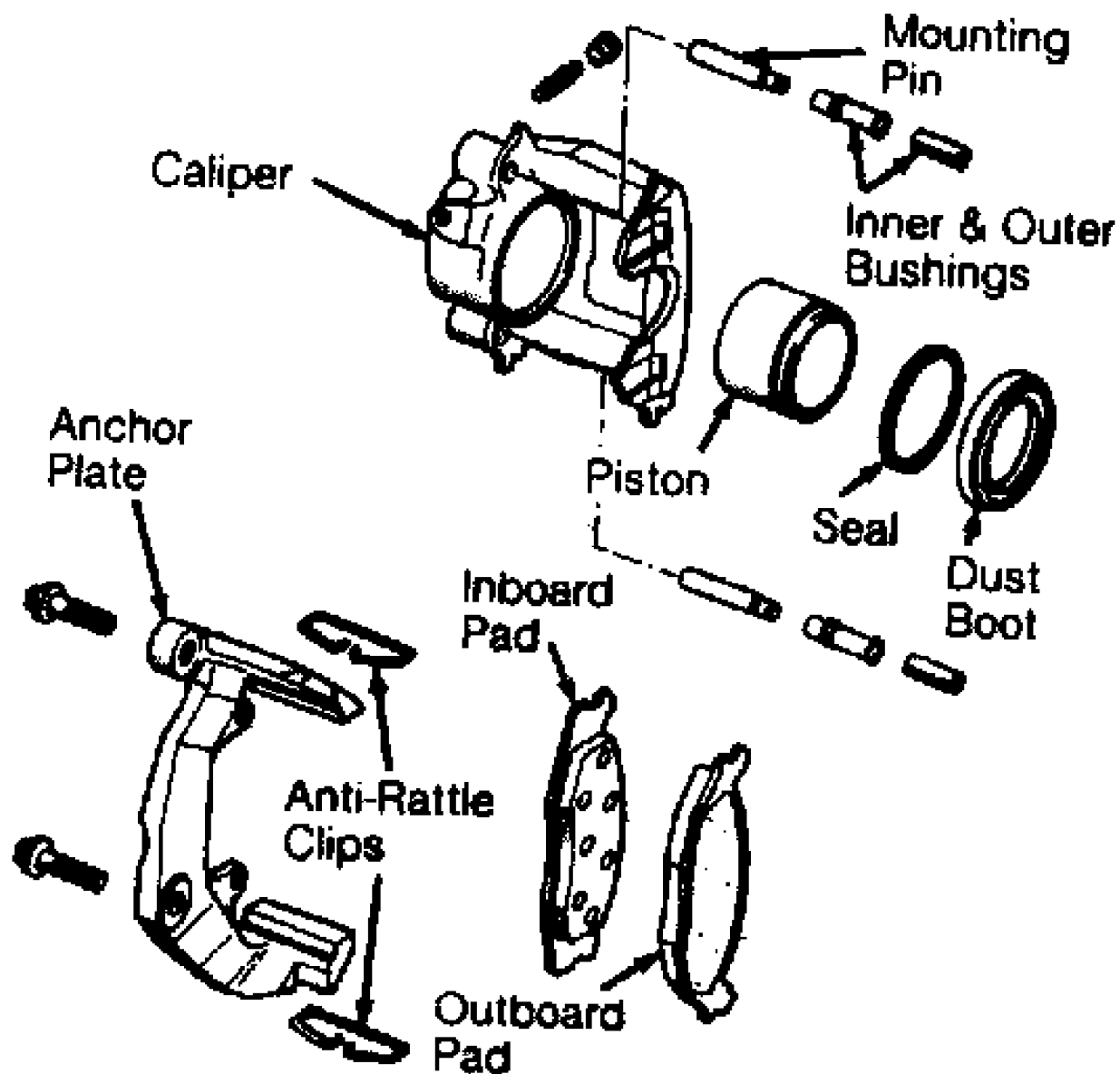


Fig. 9: Exploded View Of Caliper Assembly  
Courtesy of Chrysler Motors.

## MASTER CYLINDER

NOTE: On vehicles with Anti-Lock Brake System (ABS), manufacturer does not recommend overhaul of master cylinder. If defective, replace master cylinder and power brake booster as an assembly.

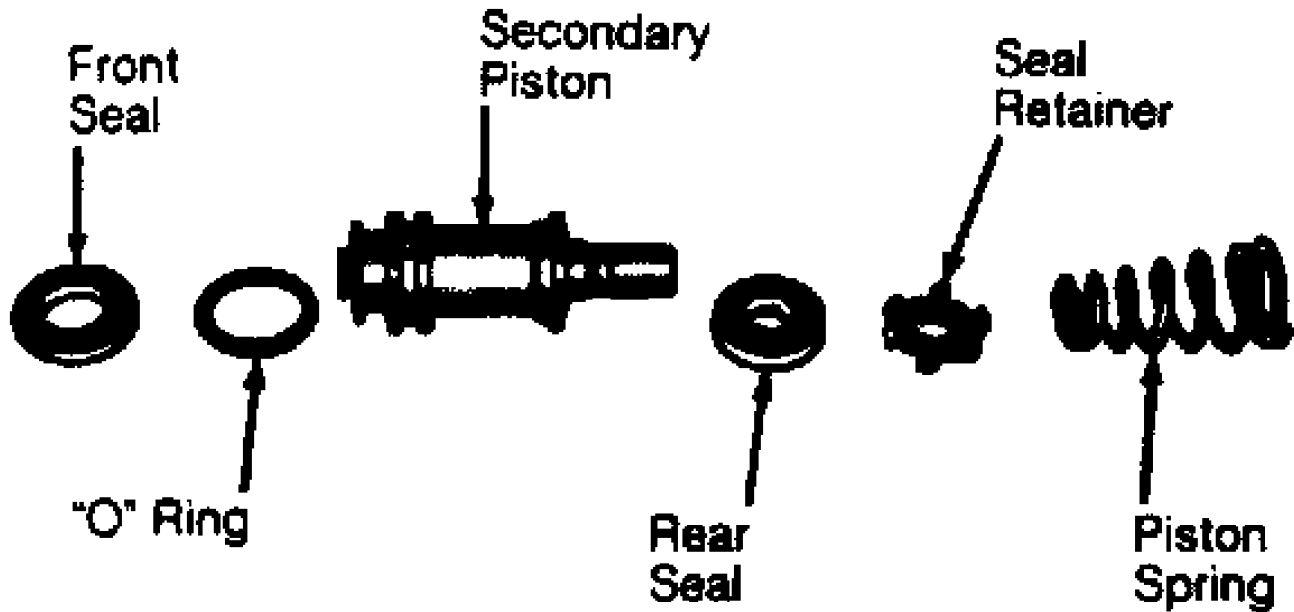


Fig. 10: Exp. View Of 2ndary Piston Components (Exc. Vehicles W/ ABS)  
 Courtesy of Chrysler Motors.

### TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Backing Plate Bolt .....	32 (43)
Brake Hose-To-Caliper .....	23 (31)
Brakeline-To-Master Cylinder .....	15 (21)
Brakeline-To-Wheel Cylinder .....	13 (18)
Caliper Mounting Pins	
2WD .....	25-35 (34-47)
4WD .....	7-15 (10-20)
Master Cylinder-To-Power Booster Nuts .....	15 (21)
Wheel Bearing .....	(1) 17-25 (23-34)
Wheel Lug Nuts	
Cherokee & Wrangler .....	75 (102)
Grand Cherokee & Grand Wagoneer .....	88 (120)
	INCH Lbs. (N.m)
Wheel Cylinder Bolts .....	72-156 (8-18)
(1) - Tighten bearing nut while rotating wheel. Loosen nut 1/2 turn, and retighten to 19 INCH lbs. (2 N.m).	

### DISC BRAKE SPECIFICATIONS

DISC BRAKE ROTOR SPECIFICATIONS TABLE

---

Application	In. (mm)
Disc Diameter .....	11.02 (279.9)
Lateral Runout	
Cherokee & Wrangler .....	.003 (.08)
Grand Cherokee & Grand Wagoneer .....	.005 (.13)
Parallelism .....	.0005 (.013)
Original Thickness .....	(1)
Minimum Refinish Thickness	
Cherokee	
2WD .....	.86 (22)
4WD .....	.89 (23)
All Others .....	.89 (23)

(1) - Information is not available.

---

## DRUM BRAKE SPECIFICATIONS

DRUM BRAKE SPECIFICATIONS TABLE

---

Application	In. (mm)
Drum Diameter	
Cherokee & Wrangler .....	9.00 (228.6)
Grand Cherokee & Grand Wagoneer .....	(1)
Drum Width .....	(1)
Maximum Drum Refinish Diameter	
Cherokee & Wrangler .....	9.050 (230.00)
Grand Cherokee & Grand Wagoneer .....	(1)
Wheel Cylinder Diameter .....	(1)
Master Cylinder Diameter .....	(1)

(1) - Information is not available.

---

# **\* BRAKE SYSTEM UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

Brake Systems - Motorist Assurance Program  
Standards For Automotive Repair

All Makes & Models

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WIRING HARNESSSES

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW OF MOTORIST ASSURANCE PROGRAM**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt:

- 1) a Pledge of Assurance to their Customers and
- 2) the Motorist Assurance Program Standards of Service.

All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not



satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

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January 1999

## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS AND SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications.

Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

**Example:**

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

**Example:**

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

**Reasons to Require Repair or Replacement**

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

**NOTE:** When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

**Reasons to Suggest Repair or Replacement**

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

**NOTE:** Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions

and make an informed decision about how to proceed.

## BRAKES

### SERVICE PROCEDURES REQUIRED & SUGGESTED FOR PROPER VEHICLE OPERATION

Some states may have specifications that differ from OEM. Check your local/state regulations. Where state or local laws are stricter, they take precedence over these guidelines.

### ACCELEROMETERS (G SENSOR OR LATERAL)

#### ACCELEROMETER INSPECTION

Condition	Code	Procedure
Broken .....	A .....	Require replacement.
Connector loose .....	A ..	Require repair or replacement.
Loose .....	B ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Out of position .....	B .....	Require re-positioning to vehicle manufacturer's specifications.
Output signal incorrect .	B .....	Require replacement.

## ACCUMULATORS

#### ACCUMULATOR INSPECTION

Condition	Code	Procedure
Leaking .....	B .....	Require replacement.
Missing .....	C .....	Require replacement.
Pre-charge incorrect ....	B .....	Require replacement.

## ANCHOR PINS

See BACKING PLATES.

## ANTI-LOCK BRAKE SYSTEMS

**NOTE:** Anti-lock brakes are an integral part of the brake system. It is essential that the anti-lock brakes function properly when brake service is performed.

Anti-lock brake systems are commonly referred to as "ABS" and will be referred to as "ABS" throughout these guidelines. Some ABS components also function as part of a traction control system (TCS).

**WARNING:** When diagnosing and servicing high pressure components, observe safety procedures and equipment requirements established by the vehicle manufacturer to reduce the possibility of serious personal injury.

**NOTE:** Intermittent electrical conditions are often caused by a loss of ground, poor connection, or water intrusion into the wiring harness.

NOTE: Electro-magnetic interference (EMI) may be caused by incorrect installation of accessories or components. EMI can result in improper system operation.

## BACKING PLATES

### BACKING PLATE INSPECTION

Condition	Code	Procedure
Anchor pin bent .....	B ..	Require repair or replacement.
Anchor pin broken .....	A .....	Require replacement.
Anchor pin worn, affecting structural integrity ...	B .....	Require replacement.
Backing plate bent .....	B ..	Require repair or replacement.
Backing plate broken ....	A .....	Require replacement.
Backing plate cracked ...	B ..	Require repair or replacement.
Corroded, affecting structural integrity ....	A .....	Require replacement.
Loose .....	B ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Shoe lands worn .....	A ..	Require repair or replacement.

## BRAKE FLUID

CAUTION: Most manufacturers prohibit the use of DOT 5 brake fluid in a system equipped with ABS.

DOT 3, DOT 4, and DOT 5.1 brake fluids are clear or light amber in color. DOT 5 brake fluid is violet in color. Correct fluid required for the brake system is stamped on the master cylinder cover.

### BRAKE FLUID INSPECTION

Condition	Code	Procedure
Beyond service interval .	3 ..	Suggest flushing and refilling with correct fluid.
Brake fluid type incorrect .....	B ..	Require flushing and refilling with correct fluid.
Contaminated, for example, fluid other than brake fluid present .....	A or B .....	(1) Require service.
Hydraulic component .....	3 ..	Suggest flushing and refilling with correct fluid.
overhaul or replacement		
Rubber master cylinder cover gasket distorted and gummy .....	A .....	(2) Require replacement of gasket.

(1) - If a fluid other than brake fluid is present in the brake system which DOES affect the rubber parts, the required service is to:

- \* Remove all components having rubber parts from the system.
- \* Flush lines with denatured alcohol or brake cleaner
- \* Repair or replace all components having rubber parts
- \* Flush and fill with correct brake fluid. (Code A)

If a fluid other than brake fluid is present in the brake

system which DOES NOT affect the rubber parts, the required service is to flush and fill with the correct brake fluid.  
(Code B)

(2) - This condition may indicate contaminated brake fluid.

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## BRAKE FRICTION MATERIAL

See FRICTION MATERIAL.

## BRAKE PADS

See FRICTION MATERIAL.

## BRAKE PEDALS

### BRAKE PEDAL INSPECTION

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Condition	Code	Procedure
Bent, affecting performance .....	A	.. Require repair or replacement.
Broken .....	A	.. Require repair or replacement.
Pedal pad missing .....	C	.... Require replacement of pedal pad.
Pedal pad worn .....	1	..... Suggest replacement.
Pivot bushings worn, affecting performance ..	A	.... Require replacement of pivot bushings.

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## BRAKE SHOES

See FRICTION MATERIAL.

## BRAKE SHOE HARDWARE

See also SELF-ADJUSTING SYSTEMS.

### BRAKE SHOE HARDWARE INSPECTION

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Condition	Code	Procedure
Broken .....	A	..... Require replacement.
Distorted .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Surfaces rust-pitted ....	1	..... Suggest replacement.
Worn, affecting performance .....	A	..... Require replacement.

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## BRAKE STOPLIGHT SWITCHES

### BRAKE STOPLIGHT INSPECTION

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Condition	Code	Procedure
Bent .....	B	..... Require replacement.
Broken .....	A	..... Require replacement.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.

Connector melted .....	A	.....	(1) Require replacement.
Connector missing .....	C	.....	Require replacement.
Missing .....	C	.....	Require replacement.
Out of adjustment .....	B	.....	Require adjustment or replacement.
Output signal incorrect .	B	.....	Require replacement.
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ...	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ...	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ...	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

- (1) - Determine cause and correct prior to replacement of part.  
(2) - Determine cause and correct prior to repair or replacement of part.

## BULB SOCKETS

### BULB SOCKET INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Broken .....	A	.. Require repair or replacement.
Bulb seized in socket ...	A	.. Require repair or replacement.
Burned, affecting performance .....	A	..... (1) Require repair or replacement.
Burned, not affecting performance .....	2	..... (1) Suggest repair or replacement.
Connector broken .....	A	.. Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (2) Require repair or replacement.
Corroded, affecting performance .....	A	.. Require repair or replacement.
Corroded, not affecting performance .....	2	.. Suggest repair or replacement.
Leaking .....	A	.. Require repair or replacement.
Melted .....	A	..... (2) Require replacement.

Shorted .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of socket.

(2) - Determine cause and correct prior to repair or replacement of part.

## BULBS AND LEDS

NOTE: Copied from Electrical UIGs and modified. Does not include soldered-in components.

### BULB AND LED INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... (1) Require replacement.
Base burned, affecting performance .....	A	..... (2) Require repair or replacement.
Base burned, not affecting performance .....	2	..... (2) Suggest repair or replacement.
Base corroded, affecting performance .....	A	.. Require repair or replacement.
Base corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Base loose, affecting performance .....	B	.. Require repair or replacement.
Base loose, not affecting performance .....	1	.. Suggest repair or replacement.
Burned out .....	A	..... Require replacement.
Intermittent .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Seized in socket .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..... (2) Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.

Terminal loose, not  
affecting performance .. 1 .. Suggest repair or replacement.

- (1) - Application incorrect includes wrong bulb coating or color.
- (2) - Determine cause and correct prior to repair or replacement of part.

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## CALIPER HARDWARE

### CALIPER HARDWARE INSPECTION

Condition	Code	Procedure
Bent .....	A ..	Require repair or replacement.
Broken .....	A ..	Require repair or replacement.
Corroded, affecting performance .....	A ..	Require repair or replacement.
Dust boots on slider pin (bolt) missing .....	C ...	Require replacement of boots.
Dust boots on slider pin (bolt) torn .....	A ...	Require replacement of boots.
Missing .....	C .....	Require replacement.
Shim bent .....	A .....	(1) Require removal or replacement.
Shim (OE standard) missing .....	C .....	(2) Require replacement.
Shim out of position ....	B .....	(1) Require removal or replacement.
Shim worn .....	A .....	(1) Require removal or replacement.
Slider pin (bolt) bent ..	B ...	Require replacement of slider pin or bolt and lubricants.
Slider pin (bolt) rust-pitted .....	A ...	Require replacement of slider pin or bolt and lubricants.
Slider pin (bolt) worn ..	A ...	Require replacement of slider pin or bolt and lubricants.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Worn, affecting performance .....	A .....	Require replacement.

- (1) - Removal is acceptable if shim is not OE.
- (2) - Aftermarket shims may be suggested to reduce noise.

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## CALIPERS

You are not required to replace or rebuild calipers in axle sets. However, when replacing or rebuilding a caliper due to the conditions that follow, you may suggest servicing, rebuilding, or replacement of the other caliper (on the same axle) for improved performance and preventive maintenance (for example, the part is close to the end of its useful life, replacing the caliper may extend pad life, or contribute to more balanced braking).

**CAUTION:** When installing loaded calipers, it is required that friction material be matched in axle sets for consistent braking characteristics.



# CALIPER INSPECTION

Condition	Code	Procedure
Bleeder port damaged ....	A ...	Require repair or replacement of caliper.
Bleeder screw broken off in caliper .....	A .....	(1) Require repair or replacement of caliper.
Bleeder screw plugged ...	A .....	(1) Require repair or replacement of bleeder screw.
Bleeder screw seized ....	A .....	(2) Require replacement of caliper.
Casting corroded, affecting structural integrity .....	A .....	Require replacement.
Casting damaged, affecting structural integrity ...	A .....	Require replacement.
Dust boot around caliper torn .....	A .....	Require replacement of dust boot.
Leaking .....	A ..	Require repair or replacement.
Mounting pin threads damaged .....	A ...	Require repair or replacement of component with damaged threads.
Mounting pin threads stripped in caliper bracket (threads missing) .....	A ...	Require repair or replacement of caliper bracket.
Mounting pin threads stripped in steering knuckle (threads missing) .....	A ...	Require repair or replacement of steering knuckle.
Mounting pin threads stripped (threads missing) .....	A ...	Require repair or replacement of component with stripped threads.
Parking brake cable support, lever, or return spring bent .....	A ...	Require replacement of parts.
Parking brake cable support, lever, or return spring broken .....	A ...	Require replacement of parts.
Parking brake mechanism in caliper inoperative ....	A ..	Require repair or replacement.
Piston corroded (pitted or peeling chrome plating) .....	B ...	Require replacement of piston and rebuilding or replacement of caliper.
Piston damaged, affecting performance .....	B ...	Require replacement of piston and rebuilding or replacement of caliper.
Piston damaged, not affecting performance ..	.. ..	..... No service suggested or required.
Piston finish worn off ..	B ...	Require replacement of piston and rebuilding or replacement

Piston sticking .....	A .....	Require rebuilding or replacement of caliper.
Slide mechanism sticking .....	A ...	Require repair or replacement of slide mechanism.

(1) - Only required if the hydraulic system must be opened.  
 (2) - Seized is defined as a bleeder screw that cannot be removed after a practical attempt at removing. Only required if the hydraulic system must be opened.

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## CONTROLLERS

See ELECTRONIC CONTROLLERS.

## DIGITAL RATIO AXLE CONTROLLERS AND BUFFERS (DRAC AND DRAB)

### DIGITAL RATIO AXLE CONTROLLER AND BUFFER INSPECTION

Condition	Code	Procedure
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require replacement.
Connector missing .....	C .....	Require replacement.
Missing .....	C .....	Require replacement.
Output signal incorrect	B ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

(1) - Determine cause and correct prior to replacement of part.  
 (2) - Determine cause and correct prior to repair or replacement of part.

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## DISABLE SWITCHES

See SWITCHES.

## DRUMS

Determine the need to recondition based upon individual drum conditions that follow. Friction material replacement does not require drum reconditioning unless other justifications exist. DO NOT recondition new drums unless they are being pressed or bolted onto an existing hub. It is not necessary to replace drums in axle sets. However, when replacing or reconditioning a drum due to the conditions that follow, you may suggest reconditioning of the other drum on the

same axle to eliminate uneven braking behavior. Always wash drums after servicing or before installing.

#### DRUM INSPECTION

Condition	Code	Procedure
Balance weight missing .. .. .		No service suggested or required.
Bell-mouthed, affecting performance .....	A .....	Require reconditioning or replacement.
Cooling fin broken .....	.. .....	No service suggested or required.
Cracked .....	B .....	Require replacement.
Drum diameter is greater than OEM "machine to" specifications but less than "discard at" specifications, and the drum does not require reconditioning .....	1 .....	(1) Suggest replacement.
Drum diameter will exceed OEM "machine to" specifications after required reconditioning .....	B .....	(2) Require replacement.
Hard-spotted .....	2 .....	Suggest reconditioning or replacement.
Measured diameter is greater than OEM discard specifications .....	B .....	Require replacement.
Out-of-round (runout), affecting performance ..	A .....	Require reconditioning or replacement.
Out-of-round (runout), exceeding manufacturer's specifications .....	B .....	Require reconditioning or replacement.
Scored .....	B .....	Require reconditioning or replacement.
Surface threaded due to improper machining .....	B .....	Require reconditioning or replacement.
Tapered, affecting performance .....	A .....	Require reconditioning or replacement.

- (1) - Only applies to vehicles for which OEM "machine to" specifications exist. If OEM does not supply "machine to" specifications, the drum may be worn to discard specifications.
- (2) - If OEM does not supply "machine to" specifications, you may machine to discard specifications.

#### ELECTRICAL PUMPS AND MOTORS

Copied fuel pump conditions from engine UIGs & deleted pulsator from leaking conditions.

#### ELECTRICAL PUMP AND MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require replacement.
Inoperative .....	A .....	(3) Require repair or replacement.
Leaking externally .....	A ..	Require repair or replacement.
Leaking internally .....	A ..	Require repair or replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.
(1) - Determine cause and correct prior to repair or replacement of part.		
(2) - Determine source of contamination. Require repair or replacement.		
(3) - Inoperative includes intermittent operation or out of OEM specifications.		

## ELECTRONIC CONTROLLERS

### ELECTRONIC CONTROLLER INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware missing .....	C .....	Require replacement of

				hardware.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of hardware.	
Attaching hardware threads stripped (threads missing) .....	A	...	Require repair or replacement of hardware.	
Code set (if applicable) .....	A	.....	(1) Further inspection required.	
Connector broken .....	A	..	Require repair or replacement.	
Connector melted .....	A	.....	(2) Require repair or replacement.	
Connector missing .....	A	.....	Require repair.	
Contaminated .....	A	..	Require repair or replacement.	
Inoperative .....	B	..	Require repair or replacement. (3) Further inspection required.	
Leaking .....	A	..	Require repair or replacement.	
Missing .....	C	.....	Require replacement.	
Terminal broken .....	A	..	Require repair or replacement.	
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.	
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance .....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.	
Threads damaged .....	A	..	Require repair or replacement.	
Threads stripped (threads missing) .....	A	.....	Require replacement.	
Wire lead conductors exposed .....	B	..	Require repair or replacement.	
Wire lead corroded .....	A	..	Require repair or replacement.	
Wire lead open .....	A	..	Require repair or replacement.	
Wire lead shorted .....	A	..	Require repair or replacement.	

- (1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
- (2) - Determine cause and correct prior to repair or replacement of part.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable. Check for accepted cleaning procedure.

## FLUID

See BRAKE FLUID.

## FLUID LEVEL SENSOR SWITCHES

See SWITCHES.

## FOUR WHEEL DRIVE SWITCHES

See SWITCHES.

## FRICTION MATERIAL

NOTE: Original Equipment Manufacturer (OEM) specifications designate replacement at different thicknesses.

CAUTION: It is required that friction material be matched in axle sets for consistent braking characteristics.

### FRICTION MATERIAL INSPECTION

Condition	Code	Procedure
Contaminated, for example, fluid that leaked from caliper, wheel cylinder, or axle seal .....	A .....	(1) Require replacement.
Cracked through .....	B .....	Require replacement.
Flaking or chunking .....	B .....	Require replacement.
Glazed (shiny) .....	.. .....	No service suggested or required.
Grooves or ridges .....	.. ....	(2) No service suggested or required.
Permanently attached hardware bent .....	A .....	Require replacement.
Permanently attached hardware broken .....	A .....	Require replacement.
Permanently attached hardware loose .....	A .....	Require replacement.
Permanently attached hardware missing .....	C .....	Require replacement.
Permanently attached hardware seized .....	A ..	Require repair or replacement.
Rivets loose .....	B .....	Require replacement.
Separating from backing ..	B .....	Require replacement.
Shoe table or web bent ..	B .....	Require replacement.
Shoe table or web cracked .....	A .....	Require replacement.
Shoe table or web worn, affecting performance ..	A .....	Require replacement.
Surface cracking .....	.. .....	No service suggested or required. Further inspection may be necessary to determine cause.
Tapered wear .....	B .....	(3) Suggest replacement.
Thickness of one pad is greater than opposite pad in the same caliper (uneven wear) .....	.. ....	(4) Replacement of friction material not suggested or required. Further inspection required. See CALIPERS and CALIPER HARDWARE.
Wear indicator device (electronic) contacts rotor .....	B .....	(5) Require replacement of appropriate parts.
Wear indicator device (mechanical) bent .....	.. .....	(6) Further inspection required.
Wear indicator device (mechanical) broken ....	.. .....	(6) Further inspection required.

Worn close to minimum				
specifications	.....	1	.....	(7) Suggest replacement.
Worn to, or below minimum				
specifications	.....	B	.....	Require replacement.

- (1) - Identify and repair cause of contamination prior to replacing friction material.
- (2) - When reconditioning or replacing drums or rotors, replacement of friction material may be suggested depending on the severity of the grooves or ridges.
- (3) - Some vehicles use pads that are tapered by design. Refer to specific vehicle application. If not normal, require replacement of pads and correction of cause.
- (4) - Uneven pad thickness is normal on some vehicles. Refer to specific vehicle applications.
- (5) - The pad wear indicator light may come on due to other electrical problems.
- (6) - Explain to the customer that the purpose of the wear indicator is to alert him or her to check for friction wear. Wear indicators may be bent or broken. Therefore, the friction material must be measured. The need for friction material replacement is determined based upon the conditions stated in this section. Periodic inspection is suggested.
- (7) - When the part appears to be close to the end of its useful life, replacement may be suggested.

## G SENSORS

See ACCELEROMETERS.

## HOSES

## HOSE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Blistered .....	B	..... Require replacement.
Fitting threads damaged .	A	.. Require repair or replacement.
Fitting threads stripped (threads missing) .....	A	..... Require replacement.
Incorrectly secured .....	B	..... Require repair.
Inner fabric (webbing) cut .....	B	..... Require replacement.
Leaking .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Outer covering is cracked to the extent that inner fabric of hose		

is visible .....	B	.....	Require replacement.
Restricted .....	A	.....	Require replacement.
Routed incorrectly .....	B	.....	Require repair.

## HYDRAULIC MODULATORS

NOTE: Many modulators can only be replaced as complete assemblies. Whenever possible, replace the failed component part. If replacement of the failed part is not possible, then replace the modulator assembly.

### HYDRAULIC MODULATOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require replacement.
Connector missing .....	C	..... Require replacement.
Disabled .....	A	.. Require repair or replacement.
Electrical failure .....	A	.. Require repair or replacement.
External leak .....	A	.. Require repair or replacement.
Housing cracked .....	B	.. Require repair or replacement.
Inoperative (2) .....	A	.. Require repair or replacement.
Internal leak .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Valve stuck .....	A	.. Require repair or replacement.
Wire lead burned .....	A	.. Require repair or replacement.
Wire lead conductors exposed .....	B	.. Require repair or replacement.
Wire lead open .....	A	.. Require repair or replacement.
Wire lead shorted .....	A	.. Require repair or replacement.

- (1) - Determine cause and correct prior to replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.



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## HYDRO-BOOSTERS

NOTE: Hydro-boosters and hydro-electric boosters are combined.

### HYDRO-BOOSTER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require replacement.
Connector missing .....	C .....	Require replacement.
Does not apply assist, or inadequate assist .....	A ..	Require repair or replacement.
Leaking .....	B ..	Require repair or replacement.
Leaks fluid at fitting ..	B .....	Require tightening or replacement.
Leaks fluid at unit .....	B ..	Require repair or replacement.
Leaks fluid from pressure hose(s) .....	B .	Require replacement of hose(s).
Leaks fluid into passenger compartment .....	B ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

(1) - Determine cause and correct prior to replacement of part.

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## HYDRO-ELECTRIC BOOSTERS (POWERMASTER)

See HYDRO-BOOSTERS.

## IGNITION DISABLE SWITCHES

See SWITCHES.

## LATERAL ACCELERATION SWITCHES

See ACCELEROMETERS.

## LEDS

See BULBS AND LEDS.

## LENSES

### LENSE INSPECTION

Condition	Code	Procedure
Application incorrect ...	A	Require replacement.
Attaching hardware broken .....	A	Require repair or replacement of hardware.
Attaching hardware missing .....	C	Require replacement of hardware.
Attaching hardware not functioning .....	A	Require repair or replacement of hardware.
Broken, affecting performance .....	A	Require replacement.
Broken, not affecting performance .....	..	No service suggested or required.
Cracked .....	A	Require replacement.
Discolored .....	A	Require replacement.
Leaking .....	A	Require repair or replacement.
Melted, affecting performance .....	A	Require replacement.
Melted, not affecting performance .....	2	Suggest replacement.
Missing .....	C	Require replacement.

## MASTER CYLINDERS

### MASTER CYLINDER INSPECTION

Condition	Code	Procedure
Brake fluid leaking from rear of master cylinder bore .....	B	Require repair or replacement.
Brake pedal drops intermittently .....	A	(1) Require repair or replacement.
Fluid level low .....	..	(2) Further inspection required.
Internal valve failure ..	A	Require repair or replacement.
Master cylinder leaking brake fluid internally ..	A	Require repair or replacement.
Piston does not return ..	A	Require repair or replacement.
Ports plugged .....	A	Require repair or replacement.
Rubber master cylinder cover gasket distorted and gummy .....	A	(3) Require replacement of the gasket.

- (1) - This condition may be normal on some vehicles equipped with anti-lock brakes.
  - (2) - Refer to OEM procedures for adjusting low fluid level. Inspect for brake hydraulic system leaks and friction material wear.
  - (3) - This condition may indicate contaminated brake fluid. See BRAKE FLUID.
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## MODULATORS

See HYDRAULIC MODULATORS.

## MOTORS

See ELECTRICAL PUMPS AND MOTORS.

## PARKING BRAKE SWITCHES

See SWITCHES.

## PARKING BRAKE SYSTEMS

**NOTE:** The parking brake is an integral part of the brake system. It is important that the parking brake function properly when brake service is performed.

### PARKING BRAKE SYSTEM INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Cable improperly adjusted .....	B .....	Require cable adjustment.
Cable or individual wires in the cable are broken .....	A ....	Require replacement of cable assembly.
Cable sticking .....	A .....	Require cable lubrication.
Cable stuck inside conduit and cannot be lubricated so that parking brake functions properly .....	A ....	Require replacement of cable assembly.
Inoperative (1) .....	A .....	Require replacement of inoperative parts.
Parking brake parts bent .....	B ...	Require repair or replacement of bent parts.
Parking brake parts broken .....	A ...	Require replacement of broken parts.
Parking brake parts		

missing .....	C	..	Require replacement of missing parts.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - Inoperative includes intermittent operation.

## PADS

See FRICTION MATERIAL.

## PEDAL TRAVEL SWITCHES

See SWITCHES.

## PEDALS

See BRAKE PEDALS.

## POWERMASTER

See HYDRO-BOOSTERS.

## PUMPS

See ELECTRICAL PUMPS AND MOTORS.

## PRESSURE DIFFERENTIAL SWITCHES

See SWITCHES.

## PRESSURE SWITCHES

See SWITCHES.

## RELAYS

NOTE: Copied from Electrical UIGs

### RELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Housing broken .....	A	..... Require replacement.
Housing cracked .....	2	..... Suggest replacement.
Inoperative (1) .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance ..	A	..... (2) Require repair or replacement.

Terminal burned, not affecting performance	..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance	..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance	..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....		B	..	Require repair or replacement.
Terminal loose, not affecting performance	..	1	..	Suggest repair or replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.
- (2) - Determine cause and correct prior to repair or replacement of part.

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## ROTORS

Determine the need to recondition based upon individual rotor conditions that follow. Friction material replacement does not require rotor reconditioning unless other justifications exist. DO NOT recondition new rotors unless they are being pressed or bolted onto an existing hub. It is not necessary to replace rotors in axle sets. However, when replacing or reconditioning a rotor due to the conditions that follow, you may suggest reconditioning of the other rotor on the same axle to eliminate uneven braking behavior.

Determine the need to replace based upon the individual rotor conditions that follow. Reconditioning is defined as machining and block sanding, or block sanding only. Block sanding is defined as using 120-150 grit sandpaper with moderate to heavy force for 60 seconds per side. Always wash rotors after servicing or before installing.

### ROTOR INSPECTION

Condition	Code	Procedure
Corrosion affecting structural integrity	... A	..... (1) Require replacement.
Cracked	..... B	..... Require replacement.
Hard spots	..... 2	..... Suggest reconditioning or replacement of rotor according to OEM specifications.
Lateral runout (wobble) exceeds OEM specifications	..... B	..... Require re-indexing, reconditioning, or replacement according to specifications.
Measured thickness is less than OEM discard specifications	..... B	..... Require replacement.
Rotor thickness is less than OEM "machine to" specifications but thicker than "discard at" specifications, and the rotor does not require reconditioning	..... 1	..... (2) Suggest replacement.
Rotor thickness will be less than OEM "machine to" specifications after required		

reconditioning .....	B	.....	(3) Require replacement.
Surface is rust-pitted ..	B	.....	Require reconditioning or replacement of rotor according to OEM specifications.
Surface is scored .....	B	...	(4) Require reconditioning or replacement of rotor according to OEM specifications.
Thickness variation (parallelism) exceeds OEM specifications .....	B	.....	Require reconditioning or replacement of rotor according to OEM specifications.

(1) - Examples of severe corrosion are: composite plate separated from friction surfaces and cooling fins cracked or missing.

(2) - Only applies to vehicles for which OEM "machine to" specifications exist. If OEM does not supply "machine to" specifications, the rotor may be worn to discard specifications.

(3) - If OEM does not supply "machine to" specifications, you may machine to discard specifications.

(4) - Scoring is defined as grooves or ridges in the friction contact surface. Some vehicle manufacturers require machining when scoring exceeds their allowable specifications.

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## SELF-ADJUSTING SYSTEMS

### SELF-ADJUSTING SYSTEM INSPECTION

Condition	Code	Procedure
Bent .....	A	... Require repair or replacement of bent part.
Broken .....	A	... Require repair or replacement of broken part.
Inoperative .....	A	..... (1) Require repair or replacement of inoperative parts.
Missing .....	C	..... Require replacement of missing part.
Star wheel does not turn freely .....	A	.. Require repair or replacement.

(1) - Inoperative includes intermittent operation.

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## SHOE HARDWARE

See BRAKE SHOE HARDWARE.

## SHOES

See FRICTION MATERIAL.

## SOCKETS

See BULB SOCKETS.

## SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE)

NOTE: Copied Vehicle Speed Sensors from Engine UIGs & added  
Air Gap incorrect, loose, and wire lead misrouted. For  
"contaminated" removed coolant & fuel examples from note.

#### SPEED SENSOR INSPECTION

Condition	Code	Procedure
Air gap incorrect .....	B .....	(1) Require adjustment or replacement.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ..	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(2) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(3) Require repair or replacement.
Inoperative .....	B .....	(4) Require repair or replacement. Further inspection required.
Lead routing incorrect ..	B .....	Require rerouting according to vehicle manufacturer's specifications.
Leaking .....	A ..	Require repair or replacement.
Loose .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Sensor housing cracked ..	2 .....	Suggest replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance ..	A .....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance ..	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead misrouted .....	B .	Require re-routing according to vehicle manufacturer's

specifications.

Wire lead open ..... A .. Require repair or replacement.  
 Wire lead shorted ..... A .. Require repair or replacement.

- (1) - If a sensor is not adjustable, further inspection is required to identify and correct cause.
- (2) - Determine cause and correct prior to repair or replacement of part.
- (3) - Determine source of contamination, such as metal particles or water. Require repair or replacement.
- (4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## STEEL BRAKE LINES

### STEEL BRAKE LINE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Corroded, affecting structural integrity ...	A .....	Require replacement.
Fitting incorrect (for example, compression fitting) .....	B .....	Require replacement.
Flare type incorrect ....	B ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Line material incorrect (copper, etc.) .....	B .....	Require replacement.
Restricted .....	A .....	Require replacement.
Routed incorrectly .....	B .....	Require routing correction.
Rust-pitted .....	1 .....	Suggest replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## STOPLIGHT SWITCHES

See BRAKE STOPLIGHT SWITCHES.

## SWITCHES

NOTE: Copied from Electrical UIGs & added "float saturated" from old fluid level sensor switches.

### STEEL BRAKE LINE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.



Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Binding, affecting performance .....	A	..	Require repair or replacement.
Binding, not affecting performance .....	2	..	Suggest repair or replacement.
Broken .....	A	..	Require repair or replacement.
Burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Burned, not affecting performance .....	2	.....	(1) Suggest repair or replacement.
Cracked, affecting performance .....	A	..	Require repair or replacement.
Cracked, not affecting performance .....	1	..	Suggest repair or replacement.
Float saturated .....	A	.....	Require replacement.
Leaking .....	A	..	Require repair or replacement.
Malfunctioning .....	A	.....	(2) Require repair or replacement.
Melted, affecting performance .....	A	.....	(1) Require repair or replacement.
Melted, not affecting performance .....	2	.....	(1) Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Out of adjustment .....	B	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Won't return .....	A	..	Require repair or replacement.
Worn .....	1	.....	Suggest replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Includes inoperative, intermittent operation, or failure to perform all functions.

## TIRES

Consult the vehicle owner's manual or vehicle placard for correct size, speed ratings, and inflation pressure of the original tires.

### TIRE INSPECTION

Condition	Code	Procedure
Tire diameter incorrect, affecting ABS or TCS ...	A .....	Require replacement.
Tire pressure incorrect, affecting ABS or TCS ...	A ..	Require repair or replacement.
Tire size incorrect, affecting ABS or TCS ...	A .....	Require replacement.

## TOOTHED RINGS (TONE WHEEL)

NOTE: Copied from Drivetrain UIGs.

If the toothed ring requires replacement and cannot be replaced as a separate component, replace the assembly of which the ring is a part.

### TOOTHED RING INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B .....	Require repair or replacement.
Bent .....	B .....	Require replacement.
Contaminated, affecting performance .....	A .....	Require repair. Identify and correct cause.
Cracked .....	B .....	Require replacement.
Loose .....	A .....	Require replacement of worn parts.
Missing .....	C .....	Require replacement.
Number of teeth incorrect .....	B .....	Require replacement.
Teeth broken .....	A .....	Require replacement.
Teeth damaged, affecting performance .....	A .....	Require replacement.

## VACUUM BOOSTERS

### VACUUM BOOSTER INSPECTION

Condition	Code	Procedure
Applies too much assist (oversensitive) .....	A .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Auxiliary vacuum pump inoperative .....	A .....	(1) Require repair or replacement.
Check valve grommet deteriorated, affecting performance .....	A ..	Require replacement of grommet.

Check valve grommet deteriorated, not affecting performance ..	1	..	Suggest replacement of grommet.
Check valve inoperative ..	A	.....	(2) Require repair or replacement.
Check valve leaking .....	A	....	Require replacement of check valve.
Check valve missing .....	C	....	Require replacement of check valve.
Check valve noisy .....	2	.....	Suggest replacement.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(3) Require replacement.
Connector missing .....	C	.....	Require replacement.
Leaking .....	A	.....	Require replacement.
Terminal burned, affecting performance .....	A	.....	(3) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Vacuum hose filter leaking .....	A	..	Require replacement of filter.
Vacuum hose filter restricted .....	A	..	Require replacement of filter.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.  
(2) - Inoperative includes intermittent operation.  
(3) - Determine cause and correct prior to replacement of part.

## VACUUM HOSES

See HOSES.

## VALVES

### VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of

				hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.	
Leaking .....	B	..	Require repair or replacement.	
Linkage bent (rear load valves) .....	A	...	Require repair or replacement of linkage.	
Linkage broken (rear load valves) .....	A	...	Require repair or replacement of linkage.	
Linkage disconnected (rear load valves) .....	C	...	Require repair or replacement of linkage.	
Pressure out of specification .....	B	.....	Require adjustment. If not possible, require replacement.	
Seized .....	A	.....	Require replacement.	
Sticking .....	A	..	Require repair or replacement.	
Terminal burned, affecting performance ..	A	.....	(1) Require repair or replacement.	
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance .....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.	
Threads damaged .....	A	..	Require repair or replacement.	
Threads stripped (threads missing) .....	A	.....	Require replacement.	
Wire lead burned .....	A	..	Require repair or replacement.	
Wire lead conductors exposed .....	B	..	Require repair or replacement.	
Wire lead open .....	A	..	Require repair or replacement.	
Wire lead shorted .....	A	..	Require repair or replacement.	
(1) - Determine cause and correct prior to repair or replacement of part.				

## WHEEL ATTACHING HARDWARE

For conditions noted below, also check condition of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow manufacturer's torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

### WHEEL ATTACHING HARDWARE INSPECTION

Condition	Code	Procedure
Bent .....	A	..... Require replacement.
Broken .....	A	..... (1) Require replacement.
Loose .....	B	... Require repair or replacement of affected component.

Lug nut flats rounded ...	A	.....	Require replacement of nut.
Lug nut installed backward .....	B	.....	Require repair.
Lug nut mating surface dished .....	A	.....	Require replacement of nut.
Lug nut mating type incorrect .....	B	.....	Require replacement of nut.
Lug nut seized .....	A	.....	Require replacement of nut and/or stud.
Stud incorrect .....	B	....	Require replacement of stud.
Threads damaged .....	A	...	Require repair or replacement of component with damaged threads.
Threads stripped (threads missing) .....	A	.....	Require replacement of component with stripped threads.

- (1) - Some manufacturers require replacement of all studs on any wheel if two or more studs or nuts on the same wheel are broken or missing.

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## WHEEL BEARINGS, RACES AND SEALS

NOTE: Grease seal replacement is required if seal is removed. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

### WHEEL BEARINGS, RACES AND SEALS INSPECTION

Condition	Code	Procedure
Axle seal on drive axle leaking .....	A .	Require replacement of seal and inspection of axle, bearing, housing, and vent tube.
Bearing end-play exceeds specifications .....	B ..	Require adjustment of bearing, if possible. If proper adjustment cannot be obtained, require replacement of bearing assembly.
Bearing rollers, balls or races are worn, pitted, or feel rough when rotated as an assembly .....	B ..	Require replacement of bearing assembly.
Seal leaking .....	A .....	(1) Require replacement of seal and inspection of bearings.
Spindle worn .....	B ..	Require replacement of spindle and bearings.

- (1) - Require inspection of mating and sealing surface and repair or replace as necessary. Check vent. A plugged vent may force fluid past the seal.

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## WHEEL CYLINDERS

You are not required to replace or rebuild wheel cylinders in axle sets. However, when rebuilding or replacing a wheel cylinder due

to the conditions that follow, you may suggest rebuilding or replacement of the other wheel cylinder (on the same axle) for preventive maintenance, for example, the part is close to the end of its useful life.

Determine the need to rebuild or replace based upon the individual wheel cylinder conditions that follow.

#### WHEEL CYLINDER INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B	..... Require replacement of bent parts.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware corroded, affecting structural integrity ...	A	. Require replacement of corroded parts.
Attaching hardware loose .....	A	.. Require repair or replacement.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bleeder port damaged (if non-repairable) .....	A	..... Require replacement.
Bleeder screw broken off in wheel cylinder (if non-repairable) .....	A	..... (1) Require replacement.
Bleeder screw plugged ...	A	..... (1) Require repair or replacement of bleeder screw.
Bleeder screw seized ....	A	..... (2) Require replacement.
Bore corroded (pitted) ..	B	..... Require replacement.
Bore grooved .....	A	..... Require replacement.
Bore oversized .....	B	..... Require replacement.
Dust boot missing .....	C	..... Require replacement of dust boot.
Dust boot torn .....	A	. (3) Require replacement of dust boot.
Leaking .....	A	..... (4) Require rebuilding or replacement.
Piston corroded, affecting performance .....	B	... Require replacement of piston and rebuilding or replacement of wheel cylinder.
Piston finish worn off ..	B	... Require replacement of piston and rebuilding or replacement of wheel cylinder.
Piston stuck in bore ....	A	.... Require replacement of wheel cylinder.
Loose .....	B	.. Require repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.

(1) - Only required if the hydraulic system must be opened.

(2) - Seized is defined as bleeder screw that cannot be removed after a practical attempt at removing. Only required if the hydraulic system must be opened.

- (3) - Inspect for conditions related to wheel cylinder.  
 (4) - Leaking is defined as a drop or more. Dampness is normal.

## WIRING HARNESSSES

NOTE: Copied from Electrical UIGs.

### WIRING HARNESS INSPECTION

Condition	Code	Procedure
Application incorrect ...	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Insulation damaged, conductors exposed .....	A ..	Require repair or replacement.
Insulation damaged, conductors not exposed ..	1 .....	Suggest replacement.
Open .....	A ..	Require repair or replacement.
Protective shield (conduit) melted .....	2 .....	(1) Suggest repair or replacement.
Protective shield (conduit) missing .....	2 ..	Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A ..	Require repair or replacement.
Routed incorrectly .....	B .....	Require repair.
Secured incorrectly .....	B .....	Require repair.
Shorted .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Voltage drop out of specification .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.





## C - SPECIFICATIONS

### 1993 Jeep Cherokee

#### 1993 ENGINE PERFORMANCE

Chrysler Corp. - Service & Adjustment Specifications

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## INTRODUCTION

Use this article to quickly find specifications related to servicing and on-vehicle adjustments. This is a quick-reference article for when you are familiar with an adjustment procedure and only need a specification.

## CAPACITIES

### BATTERY SPECIFICATIONS

Application	Group	Cold Crank Amps @ 0 °F (-18 °C)
2.5L .....	58 .....	390
4.0L		
Cherokee .....	58 .....	475
Grand Cherokee ....	34 .....	600
5.2L .....	34 .....	600

### FLUID CAPACITIES

Application	(1) Quantity
Crankcase (2)	
2.5L .....	5.0 Qts. (4.7L)
4.0L .....	6.0 Qts. (5.7L)
5.2L .....	5.0 Qts. (4.7L)
Cooling System (Includes Heater)	
2.5L	
Cherokee .....	10.0 Qts. (9.5L)
Wrangler .....	9.0 Qts. (8.5L)
4.0L	
Cherokee .....	12.0 Qts. (11.4L)
Grand Cherokee .....	9.3 Qts. (8.8L)
Wrangler .....	10.5 Qts. (9.9L)
5.2L	
Grand Cherokee .....	14.9 Qts. (14.1L)
Automatic Transmission (3)	
AW-4 (4) .....	8.5 Qts. (8.0L)
32RH (4) .....	8 Qts. (7.6L)
42RE (5) .....	10.2 Qts. (9.6L)
Manual Transmission (API GL-5 75W-90)	
AX-5 (2WD 5-Speed) .....	7.4 Pts. (3.5L)
AX-5 (4WD 5-Speed) .....	7.0 Pts. (3.3L)
AX-15 (5-Speed) .....	6.7 Pts. (3.2L)
Front/Rear Axles (API GL-5 75W-90)	
Cherokee (6) .....	2.5 Pts. (1.2L)
Grand Cherokee (7) (8) .....	3.0 Pts. (1.4L)
Wrangler (7) (8) .....	2.5 Pts. (1.2L)
Wrangler (H/D Axle) (5) (6) .....	3.0 Pts. (1.4L)
Transfer Case (Mercon or Dexron-II)	
Command-Trac 231	
Except Wrangler .....	2.2 Pts. (1.0L)

Wrangler .....	3.3 Pts. (1.5L)
Model 249 .....	3.0 Pts. (1.4L)
Selec-Trac 242 .....	3.0 Pts. (1.4L)

- (1) - Fluid capacities listed are approximate. Always fill to FULL mark.
- (2) - Includes oil filter.
- (3) - Drain and refill capacity only. Does not include torque converter.
- (4) - Mercon or Dexron-II fluid.
- (5) - Mopar ATF Plus fluid only.
- (6) - With trailer towing package (5000 lbs.), use 75W-140 synthetic gear oil.
- (7) - With trailer towing package use API GL-5 80W-140.
- (8) - With limited slip differential, add 2 ounces of friction modifier.
- 

## QUICK-SERVICE

### SERVICE INTERVALS & SPECIFICATIONS

#### REPLACEMENT INTERVALS

Component	Miles
Oil & Filter .....	7,500
Air Filter .....	30,000
Coolant .....	45,000
Fuel Filter .....	30,000
Oxygen Sensor .....	75,000
Spark Plugs .....	30,000

#### BELT ADJUSTMENT (Tension In Lbs. (kg) Using Belt Tension Gauge)

Application	Tension
Serpentine Belt (1)	
New Belts .....	180-200 (81.72-90.8)
Used Belts .....	140-160 (63.56-72.64)
V-Belt	
New Belts .....	120-160 (54.48-72.64)
Used Belts .....	90-115 (40.86-52.21)

- (1) - Grand Cherokee is equipped with automatic belt adjustment.
- 

## MECHANICAL CHECKS

### ENGINE COMPRESSION

Check engine compression with engine at normal operating temperature, all spark plugs removed and throttle wide open.

NOTE: Compression pressure and cylinder pressure variation for 2.5L and 4.0L engines are not available from manufacturer at time of publication.

#### COMPRESSION SPECIFICATIONS

---

Application	Specification
2.5L	
Cherokee .....	9.2:1
Wrangler .....	9.1:1
4.0L .....	8.8:1
5.2L .....	9.1:1
Normal Compression Pressure ...	120-150 psi (827-1034 kPa)
Minimum Compression Pressure .....	100 psi (689 kPa)
Maximum Variation Between Cylinders .....	5 psi (172 kPa)

## VALVE CLEARANCE

NOTE: Vehicles are equipped with hydraulic lifters. No adjustments are required.

## IGNITION SYSTEM

### IGNITION COIL

IGNITION COIL RESISTANCE - Ohms @ 68°F (20°C)

Application	Primary	Secondary
Diamond Coil .....	.97-1.18 .....	11,300-15,300
Toyodenso Coil .....	.95-1.20 .....	11,300-13,300

## HIGH TENSION WIRE RESISTANCE

HIGH TENSION WIRE RESISTANCE

Application	Ohms
All Wires .....	250-1000 per inch

## SPARK PLUGS

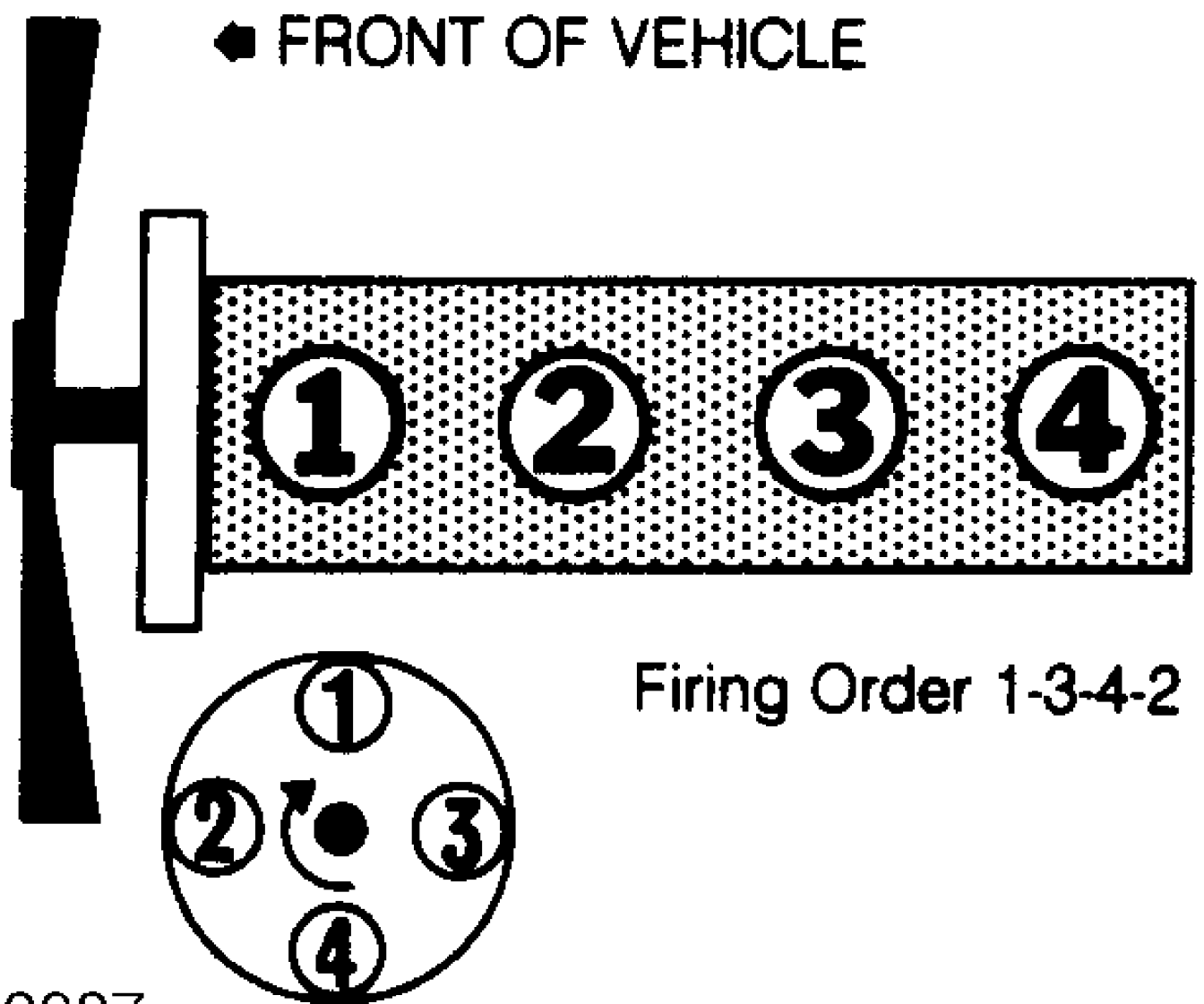
SPARK PLUG TYPE

Application	Specification
2.5L & 4.0L .....	Champion RC-12 LYC
5.2L .....	Champion RC-12YC

SPARK PLUG SPECIFICATIONS

Application	Gap: In. (mm)	Torque: Ft. Lbs. (N.m)
2.5L, 4.0L & 5.2L ..	.035 (.89) .....	27 (37)

## FIRING ORDER & TIMING MARKS



9087

Fig. 1: Firing Order & Timing Marks (2.5L)

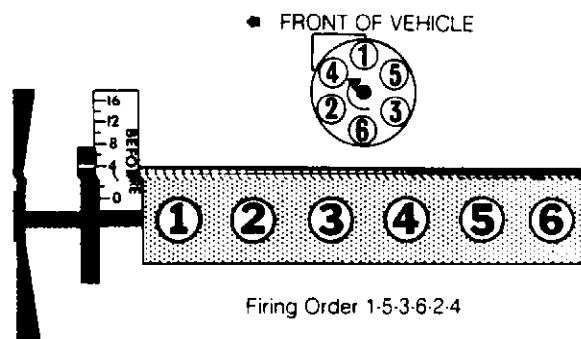
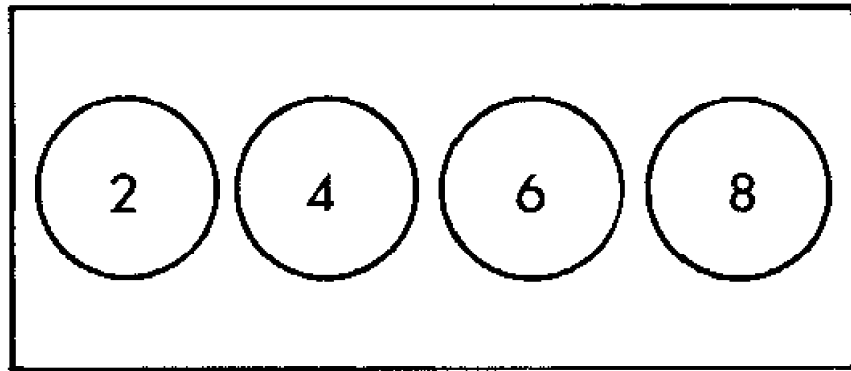
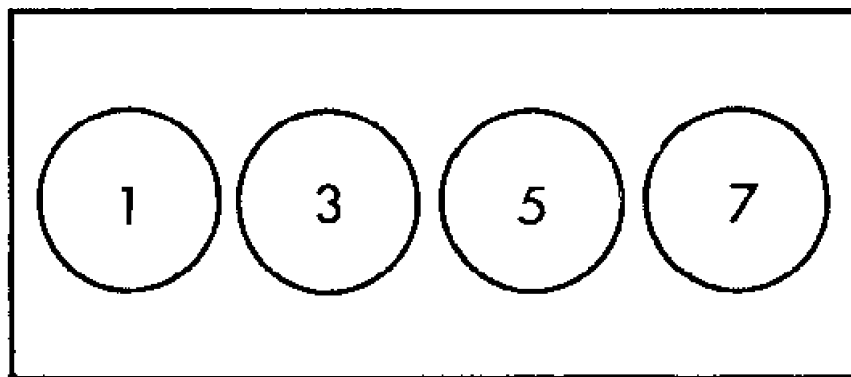
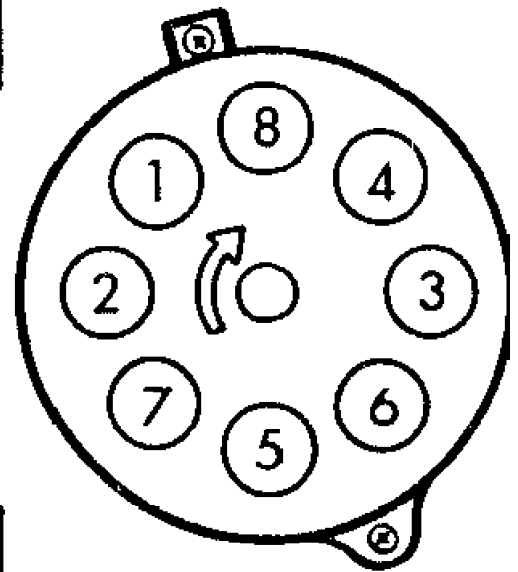


Fig. 2: Firing Order & Timing Marks (4.0L)

← FRONT OF ENGINE



FIRING ORDER 1-8-4-3-6-5-7-2



95E35778

Fig. 3: Firing Order & Distributor Rotation (5.2L)  
Courtesy of Chrysler Corp.

#### IGNITION TIMING

Vehicles are equipped with Powertrain Control Module (PCM) computerized ignition. PCM controls ignition timing. No adjustment is possible.

#### DISTRIBUTOR SPECIFICATIONS

Vehicles are equipped with Powertrain Control Module computerized ignition. Distributor's only function is to distribute high voltage to appropriate spark plug. No adjustments are required.

## FUEL SYSTEM

### FUEL PUMP

NOTE: Fuel pump performance refers to fuel pressure and volume availability, not regulated fuel pressure.

#### FUEL PUMP PERFORMANCE

Application	psi (kg/cm <sup>2</sup> )	Minimum Volume In 30 sec.
2.5L, 4.0L & 5.2L	..... 39 (2.70)	..... 1 Pt. (.47L)

#### REGULATED FUEL PRESSURE

Application	psi (kg/cm <sup>2</sup> ) At Idle
With Vacuum	..... 31 (2.18)
Without Vacuum	..... 39 (2.70)

### INJECTOR RESISTANCE

#### INJECTOR RESISTANCE - Ohms @ 68°F (20°C)

Application	Specification
2.5L, 4.0L & 5.2L	..... 12.8-15.2

### IDLE SPEED & MIXTURE

NOTE: Idle mixture is controlled by the Powertrain Control Module (PCM). Adjustment is not required or possible.

### THROTTLE POSITION SENSOR (TPS)

2.5L, 4.0L & 5.2L

Output voltage (center terminal of TPS) should be .20 volts at closed throttle and less than 4.8 volts at WOT. TPS is not adjustable.

# COMPUTER RELEARN PROCEDURES

## 1993 Jeep Cherokee

1991-93 GENERAL INFORMATION  
Chrysler Motors Computer Relearn Procedures

All Domestic Models

### INTRODUCTION

Vehicles equipped with engine or transmission computers may require a relearn procedure after the vehicle battery is disconnected. Many vehicle computers memorize and store vehicle operation patterns for optimum driveability and performance. When the vehicle battery is disconnected, this memory is lost. The computer will use default data until new data from each key start is stored. As the computer memorizes vehicle operation for each new key start, driveability is restored. Vehicle computers may memorize vehicles operation patterns for 40 or more key starts.

Customers often complain of driveability problems during the relearn stage because the vehicle acts differently then before being serviced. Depending on the type and make of vehicle and how it is equipped, the following complaints (driveability problems) may exist:

- \* Harsh Or Poor Shift Quality
- \* Rough Or Unstable Idle
- \* Hesitation Or Stumble
- \* Rich Or Lean Running
- \* Poor Fuel Mileage

These symptoms and complaints should disappear after a number of drive cycles have been memorized. To reduce the possibility of complaints, after any service which requires battery power to be disconnected, vehicle should be road tested. These procedures are especially important if the vehicle is equipped with an electronically controlled automatic transmission or transaxle. Always complete the procedure before returning the vehicle to the customer.

### COMPUTER RELEARN PROCEDURES

#### ALL EXCEPT VEHICLES WITH A-604 TRANSAXLE

NOTE: If repairs other than battery replacement have been made to late model Chrysler Motors vehicles, always refer to verification tests VER-1, 2, and 3 in the ENGINE PERFORMANCE section.

##### Automatic Transmission

- \* Set parking brake, and start engine in "P" or "N" position. Warm-up vehicle to normal operating temperature or until cooling fan cycles.
- \* Allow vehicle to idle for one minute in "N" position. Select "D" and allow engine to idle for one minute.
- \* Accelerate at normal throttle position (20-50%) until vehicle shifts into top gear.
- \* Cruise at light to medium throttle.
- \* Decelerate to a stop, allowing vehicle to downshift, and use brakes normally.
- \* Process may be repeated as necessary.

##### Manual Transmission

- \* Place transmission in Neutral position.

- \* Ensure the emergency brake has been set and all accessories are turned off.
- \* Start engine and bring to normal operating temperature.
- \* Allow vehicle to idle in Neutral for one minute.
- \* Initial relearn is complete; process will be completed during normal driving.

## VEHICLES WITH A-604 TRANSAXLE

**NOTE:** If repairs other than battery replacement have been made to late model Chrysler Motors vehicles, always refer to verification tests VER-1, 2, and 3 in the ENGINE PERFORMANCE section.

This procedure should be used on any Chrysler vehicle equipped with an A-604 transaxle. It will quickly optimize shift quality after disconnecting battery or loss of voltage supply to the transaxle controller.

1) Warm transaxle to normal operating temperature by allowing engine to idle for proper time depending on ambient temperature. See TRANSAXLE FLUID WARM-UP TIME table.

TRANSAXLE FLUID WARM-UP TIME TABLE

Ambient Temperature	Engine Idle Time (Minutes)
0°F (-18°C)	8
20°F (-7°C)	6
40°F (4°C)	4
60°F (16°C)	2
80°F (27°C)	0

2) To set transaxle upshift learn procedure, operate vehicle and maintain constant throttle opening during shifts.

**CAUTION:** DO NOT move accelerator pedal during transaxle upshifts.

3) Accelerate vehicle with throttle opening angle in range of 10 to 50 degrees. Operate vehicle until transaxle performs 1-2, 2-3, and 3-4 upshifts at least 15-20 times.

**NOTE:** Accelerating vehicle from stop to approximately 45 MPH at moderate throttle angle (20-25 degrees) is sufficient.

4) To set transaxle kickdown learn procedure, operate vehicle with vehicle speed less than 25 MPH, making 5-8 wide-open throttle kickdowns to 1st gear from either 2nd or 3rd gear.

**CAUTION:** Allow transaxle to operate in 2nd or 3rd gear at least 5 seconds before performing kickdown.

5) With vehicle speed greater than 25 MPH, make 5-8 part throttle to wide-open throttle kickdowns to either 3rd or 2nd gear from 4th gear (for example, 4-3 or 4-2 kickdowns).

**CAUTION:** Operate transaxle in 4th gear for at least 5 seconds at steady throttle position before performing kickdown.



# COOLING SYSTEM SPECIFICATIONS

## 1993 Jeep Cherokee

1993 ENGINE COOLING  
Chrysler Corp. Cooling System Specifications

Jeep; Cherokee, Grand Cherokee, Wrangler

NOTE: Information for Grand Cherokee and Grand Wagoneer with 5.2L V8 engine is not available from manufacturer.

### SPECIFICATIONS

#### COOLING SYSTEM SPECIFICATIONS

COOLING SYSTEM SPECIFICATIONS TABLE

Application	Specification
Coolant Replacement Interval .....	(1) 24 months
Coolant Capacity	
Cherokee	
2.5L .....	10.0 Qts. (9.5L)
4.0L .....	12.0 Qts. (11.4L)
Grand Cherokee	
Standard Cooling System .....	9.0 Qts. (8.5L)
Heavy Duty Cooling System .....	10.0 Qts. (9.5L)
Wrangler	
2.5L .....	9.0 Qts. (8.5L)
4.0L .....	10.5 Qts. (9.9L)
Pressure Cap .....	12-16 psi
Thermostat Opens	
Starts .....	195 °F (90 °C)
Fully Open .....	218 °F (103 °C)
(1) - Manufacturer recommends replacing original coolant at 36 months or 52,500 miles, whichever occurs first.	

# **CRUISE CONTROL SYSTEM**

1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Cruise Control Systems

Jeep: Cherokee, Grand Cherokee, Grand Wagoneer

## **DESCRIPTION & OPERATION**

The cruise control system is electronically controlled and vacuum operated. The electronic control is integrated into the Powertrain Control Module (PCM) located next to the battery. System consists of the following components: PCM, servo, cruise control switch panel, vacuum reservoir, vehicle speed sensor, brakelight switch and Park/Neutral switch (automatic transmission). System controls are located on the steering wheel and consist of ON/OFF, RESUME/ACCEL and SET/DECEL buttons.

## **SYSTEM CONTROLS**

To Set Cruise Control

Press ON/OFF button to turn cruise control system on.

Accelerate to desired speed (minimum of 35 MPH) and press SET/DECEL button. Vehicle speed will be maintained.

NOTE: Cruise control system will automatically disengage when vehicle speed decreases to less than 35 MPH or increases to more than 85 MPH.

To Disengage Cruise Control

Press brake pedal or clutch pedal. The ON/OFF button may also be used, but set speed will be erased from memory. If clutch pedal is used to disengage cruise control, engine speed will increase before cruise control cuts out.

To Resume Previous Speed

If set speed has not been erased from memory and vehicle speed is more than 35 MPH, press RESUME/ACCEL button.

To Increase Speed

With cruise control system on, increase set speed by rapidly pressing and releasing RESUME/ACCEL button. Each pressing of button will cause a speed increase of 2 MPH. For example, 3 presses would result in an increased speed of 6 MPH. To increase speed gradually, hold RESUME/ACCEL button down until desired speed is reached. When button is released, new set speed will be maintained.

To Decrease Speed

With cruise control system on, decrease set speed by pressing SET/DECEL button. Vehicle speed will gradually decrease. Releasing button will set a new speed as long as vehicle speed is still more than 35 MPH.

## **SELF-DIAGNOSTIC SYSTEM**

### **SYSTEM DIAGNOSTICS**

Self-diagnostic capabilities of this system, if properly used, can simplify testing. Cruise control system is monitored by Powertrain Control Module (PCM).

If a problem is sensed with a monitored circuit, a fault code is stored in PCM. Once codes are known, refer to FAULT CODES to determine questionable circuit. Test circuits and repair or replace components as required. If problem is repaired or ceases to exist, PCM cancels that fault code after 50 ignition on/off cycles. To clear codes, refer to CLEARING FAULT CODES.

A specific fault code results from a particular system failure, but is not necessarily reason for failure. Fault code does not condemn a specific component, but calls out a probable malfunction area.

## SERVICE PRECAUTIONS

**CAUTION:** When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

Before proceeding with diagnosis, observe following precautions:

- \* Vehicle must have a fully charged battery and functional charging system.
- \* Probe PCM 60-pin connector from pin side. DO NOT backprobe PCM connector.
- \* DO NOT cause short circuits when performing electrical tests. This will set additional fault codes, making diagnosis of original problem more difficult.
- \* Always repair lowest fault code number (CHECK ENGINE light) or first fault displayed (DRB-II) before repairing others.
- \* Always perform TEST SC-VER after repairs are made.

## VISUAL INSPECTION

Perform a visual inspection before attempting to diagnose cruise control system problems. A visual inspection may quickly identify cause of a malfunction and eliminate need for diagnostic testing. A thorough visual inspection includes checking for disconnected or faulty wiring harness connectors, leaking or misrouted vacuum hoses, corroded battery terminals or bare wires.

## DIAGNOSTIC PROCEDURE

**NOTE:** When using self-diagnostic tests for diagnosis, DO NOT skip any steps or incorrect diagnosis may result. Always start with TEST SC-1A.

Perform a visual inspection before attempting to diagnose any engine control system problems. Refer to VISUAL INSPECTION. Enter on-board diagnostics and retrieve all fault codes. Refer to ENTERING ON-BOARD DIAGNOSTICS. If fault codes are NOT present and/or DRB-II (Diagnostic Readout Box II) is used, proceed to TEST SC-1A under SELF-DIAGNOSTIC TESTS.

## ENTERING ON-BOARD DIAGNOSTICS

**NOTE:** Although other scan testers are available, manufacturer recommends using DRB-II (Diagnostic Readout Box II) to diagnose system. CHECK ENGINE light function can be used, but it has limited diagnostic abilities.

NOTE: If fault code exists that is not related to cruise control system, see appropriate G - TESTS W/CODES - 2.5L & 4.0L article in the ENGINE PERFORMANCE Section.

#### CHECK ENGINE Light Diagnostic Mode

1) With key inserted in ignition switch, cycle ignition switch to ON position 3 times. On third cycle, leave ignition switch in ON position. Record 2-digit fault codes as displayed by flashing CHECK ENGINE light.

2) For example, Code 34 is displayed as a series of 3 flashes in rapid succession, followed by a 4-second pause, then 4 flashes in rapid succession. After a slightly longer pause, other stored codes are displayed in numerical order.

3) When CHECK ENGINE light begins to flash fault codes, it cannot be stopped. If you lose count, it will be necessary to start over. Code 55 indicates end of fault code display.

4) Refer to FAULT CODES to translate trouble code number to a system fault description (DRB-II display). Once trouble area is identified, refer to TEST SC-1A under SELF-DIAGNOSTIC TESTS to diagnose problem.

#### DRB-II Diagnostic Mode

1) Connect DRB-II to engine diagnostic connector. Connector is located in engine compartment, near PCM. Turn ignition switch to ON position. Enter SPEED CONTROL MENU. To enter SPEED CONTROL MENU, see DRB-II TEST FUNCTIONS.

2) At SPEED CONTROL MENU, press "2" (READ FAULTS) key. Press ENTER key. After fault codes are accessed, refer to TEST SC-1A under SELF-DIAGNOSTIC TESTS to diagnose problem. If no fault codes are present, see TROUBLE SHOOTING.

3) To erase fault codes while in this option, press ATM key. At DRB-II display, press "2" (ERASE) key. DRB-II will display ERASE FAULTS ARE YOU SURE? (ENTER TO ERASE). Press ENTER key.

4) When DRB-II is finished erasing fault codes, it will display FAULTS ERASED. This display will remain until ATM key is pressed. After ATM key is pressed, display will return to SPEED CONTROL MENU screen.

### CLEARING FAULT CODES

NOTE: Fault codes can also be cleared in READ FAULTS option of DRB-II. To ensure that all faults are read, it is advisable to use READ FAULTS option to erase fault codes. See DRB-II DIAGNOSTIC MODE under ENTERING ON-BOARD DIAGNOSTICS.

1) If DRB-II is not available, go to step 3). If DRB-II is available, enter SPEED CONTROL MENU. See DRB-II TEST FUNCTIONS. At SPEED CONTROL MENU, press "5" (ADJUSTMENTS) key. Press ENTER key. At ADJUSTMENTS menu, press "1" (ERASE FAULTS) key. Press ENTER key.

2) DRB-II will display ERASE FAULTS ARE YOU SURE? (ENTER TO ERASE). Press ENTER key. When DRB-II is finished erasing fault codes, screen will display FAULTS ERASED.

3) If DRB-II is not available, fault codes may be cleared by disconnecting negative battery cable for at least 15 seconds, allowing PCM to clear fault codes.

### FAULT CODES

#### FAULT CODES TABLE

Code	Display On DRB-II	Fault Condition
15	..... NO VEHICLE SPEED SIGNAL	..... No Vehicle Speed Sensor

"	.....	"	.....	Signal Detected During
"	.....	"	.....	Road Load Conditions
34	.....	SPEED CONTROL SOLENOID CIRCUITS	....	An Open Or Shorted
"	.....	"	.....	Condition Detected In Cruise Control
"	.....	"	.....	Vacuum Or Vent Solenoid Circuits

---

## DRB-II TEST FUNCTIONS

NOTE: For more information on DRB-II test functions, see appropriate G - TESTS W/CODES - 2.5L & 4.0L article in the ENGINE PERFORMANCE Section.

## SPEED CONTROL MENU

1) To perform cruise control system tests using DRB-II, DRB-II must be in SPEED CONTROL MENU. At SPEED CONTROL MENU, fault codes and DRB-II test functions can be accessed.

2) To reach SPEED CONTROL MENU, turn ignition off. Connect DRB-II to engine diagnostic connector. Connector is located in engine compartment, near PCM. Turn ignition switch to RUN position.

NOTE: DO NOT touch DRB-II keypad during DRB-II power-up sequence or an error message will result.

3) All DRB-II character positions will glow and copyright information will appear on screen for a few seconds. If DRB-II screen is blank or any error messages appear, see G - TESTS W/CODES - 2.5L & 4.0L article in the ENGINE PERFORMANCE Section.

4) After a few seconds DRB-II menu will appear. At DRB-II menu, press "4" (SELECT SYSTEM) key. Press ENTER key. At SELECT SYSTEM menu, press "1" (ENGINE) key. Press ENTER key. DRB-II menu will appear indicating engine year, size, type of transmission and PCM part number.

5) After a few seconds AIR COND menu will appear. Press "1" (WITH A/C) or press "2" (WITHOUT A/C). DRB-II display will change to ENGINE SYSTEMS menu. At ENGINE SYSTEMS menu, press "3" (SPEED CONTROL) key. Press ENTER key.

6) Display will change to SPEED CONTROL. At SPEED CONTROL MENU, specific test functions programmed into DRB-II can be performed. Following DRB-II modes can be accessed: SYSTEM TESTS, READ FAULTS, STATE DISPLAY, ACTUATOR TESTS and ADJUSTMENTS.

## TROUBLE SHOOTING

### \* PLEASE READ THIS FIRST \*

WARNING: If vehicle is equipped with air bag, air bag must be deactivated before servicing cruise control components on or around steering column. See AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT Section.

### NO CRUISE CONTROL WHEN SET BUTTON IS PRESSED & RELEASED

Check for: blown fuse, no vacuum at servo and/or defective servo, disconnected speed control cable, brakelight switch out of adjustment, faulty electrical circuit, faulty Park/Neutral switch input to PCM, faulty PCM.

### CRUISE CONTROL ENGAGES WITHOUT ACTUATING CRUISE SET BUTTON

Check for: defective servo, faulty electrical circuit or control switch.

### CRUISE CONTROL ENGAGES WHEN ENGINE IS STARTED

Check for: defective servo, faulty electrical circuit.

### ERRATIC SPEED OR ENGINE SHUTS OFF

Check for: poor engine performance (surge), defective vehicle speed sensor, vacuum leak, faulty servo, faulty PCM.

### CRUISE CONTROL DISENGAGES ON ROUGH ROAD

Check for: brakelight switch out of adjustment, faulty electrical circuit.

### ENGINE DOES NOT RETURN TO NORMAL IDLE

Check for: kinked and/or damaged cruise control cable, faulty throttle linkage.

### NO RESUME WHEN RESUME BUTTON IS PRESSED

Check for: defective switch, faulty electrical circuit.

### CRUISE CONTROL DOES NOT DISENGAGE WITH BRAKE PEDAL DEPRESSED

Check for: defective or improperly adjusted brakelight switch, kinked and/or damaged speed control cable, faulty electrical circuit.

## TESTING

### (WITHOUT DRB-II)

#### Brakelight Switch

Disconnect brakelight switch 6-pin connector. Using an ohmmeter, check for continuity at switch side of connector terminals. See the TESTING BRAKELIGHT SWITCH table. If continuity is not as specified, check brakelight switch adjustment. If switch adjustment is okay, replace defective brakelight switch.

#### TESTING BRAKELIGHT SWITCH TABLE

Pedal Position/Test Terminals	Continuity
Released	
1 & 4 .....	Yes
3 & 6 .....	Yes
2 & 5 .....	No
Depressed	
1 & 4 .....	No
3 & 6 .....	No
2 & 5 .....	Yes

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

## CRUISE CONTROL CIRCUIT

1) Disconnect Powertrain Control Module (PCM) connector. On XJ models, PCM is located on drivers side fender. On ZJ models, PCM is located on passenger side firewall. Using external voltmeter, connect negative lead to vehicle ground.

2) Turn ignition on. Check voltage at terminal No. 33. Voltage should be zero volts with cruise control switch in OFF position. Voltage should be battery voltage with switch in ON position. Repair harness as necessary if voltage is not correct.

3) Check voltage at terminal No. 53. Voltage should be zero volts with cruise control switch in OFF position. Voltage should be battery voltage with switch in ON position. Repair harness as necessary if voltage is not correct.

4) Check voltage at terminal No. 48. Voltage should be zero volts with cruise control switch off. Voltage should be battery voltage with switch on. With switch in ON position, voltage should drop to zero volts when SET button is pressed. Repair harness as necessary if voltage is not correct.

5) Check voltage at terminal No. 50. Voltage should be zero volts with cruise control switch in ON or OFF position. With cruise control switch in SET or RESUME position, voltage should be battery voltage. Repair harness as necessary if voltage is not correct.

6) Check voltage at terminal No. 49. Voltage should be zero volts with cruise control switch off. Voltage should be battery voltage with switch on. With cruise control switch in SET or RESUME position, voltage should be battery voltage. Repair harness as necessary if voltage is not correct.

7) Using external ohmmeter, check resistance between terminal No. 29 of PCM connector and vehicle ground. Pressing brake pedal, ohmmeter should display continuity with pedal released. With brake pedal depressed, ohmmeter should display open circuit.

## CRUISE CONTROL SERVO TEST

1) Turn ignition on. Place cruise control switch in ON position. Using external voltmeter, connect negative lead to vehicle ground. Disconnect servo connector. Check voltage at pin No. 2 (Dark Blue/Red wire) of servo connector. If voltage is less than battery voltage, check for loose connections, brake switch adjustment or damaged harness.

2) Connect a jumper wire between terminal No. 2 (Dark Blue/Red wire) of servo connector and corresponding terminal of servo. Check voltage at 3 remaining male servo terminals. If voltage is less than battery voltage at each terminal, replace servo.

3) Using external ohmmeter, measure resistance between terminal No. 1 of servo connector and vehicle ground. If resistance is more than 5 ohms, check and repair harness as needed.

## CRUISE CONTROL SWITCH - ZJ MODELS

Access cruise control switch. See Fig. 10. Disconnect cruise control switch 4-pin connector. Using an ohmmeter, check cruise control switch. If cruise control switch does not test as specified, replace switch. See TESTING CRUISE CONTROL SWITCH table.

NOTE: Testing of cruise control switch without DRB-II on XJ models is not provided by manufacturer.

### TESTING CRUISE CONTROL SWITCH TABLE

Switch Position	Check Between Pin Nos.	Ohms
-----------------	------------------------	------

OFF .....	3 & 4 .....	5890-6510
OFF .....	1 & 3 .....	(1) *
ON .....	1 & 4 .....	5890-6510
ON .....	1 & 3 .....	(2) *
ON/SET .....	3 & 4 .....	1020-1130
ON/RESUME .....	3 & 4 .....	2040-2260

(1) - No continuity should exist.

(2) - Continuity should exist.

## SERVO VACUUM

1) Remove cruise control cable from throttle body. Disconnect cruise control servo 4-pin connector. Disconnect vacuum hose at cruise control servo. Apply battery voltage to terminal No. 2 (Dark Blue/Red wire) of servo connector. Using jumper wire, ground remaining 3 terminals of servo connector.

2) Connect hand held vacuum pump to servo vacuum nipple, and apply 10-15 in. Hg of vacuum. Cruise control cable should retract and maintain position as long as vacuum is applied. If servo does not test as specified, replace servo.

## VACUUM SUPPLY

1) Disconnect vacuum hose at cruise control servo. Install vacuum gauge to disconnected vacuum hose. Start engine and observe gauge. Vacuum reading should be a minimum of 10 in. Hg. Turn engine off. Vacuum should continue to hold at a minimum of 10 in. Hg.

2) If vacuum is not as specified, check for kinked or leaking vacuum lines, defective check valve, defective vacuum reservoir and/or poor engine performance. If no problems are found, check cruise control servo. See CRUISE CONTROL SERVO TEST.

## REMOVAL & INSTALLATION

### \* PLEASE READ THIS FIRST \*

**WARNING:** If vehicle is equipped with air bag, air bag must be deactivated before servicing cruise control components on or around steering column. See AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT Section.

## CRUISE CONTROL SERVO

### Removal

Remove cruise control cable mounting bracket from servo. Remove servo mounting bracket. Disconnect wiring harness connector and vacuum hose from servo. Pull cable away from servo to expose retaining clip. Remove retaining clip and cable. Remove servo.

### Installation

With throttle in full open position, align hole in cruise control cable sleeve with hole in servo pin. Install retaining clip. To complete installation, reverse removal procedure.

## CRUISE CONTROL SWITCH

### Removal & Installation (XJ Models)

1) Disconnect negative battery cable. Remove horn button by



turning while pushing. Remove horn bushing, receiver and flexplate. Turn ignition switch to LOCK position and remove steering wheel nut with washer. Scribe alignment mark on steering wheel and steering shaft.

2) Remove vibration damper from steering column hub (if equipped). Remove steering wheel. Using appropriate compressor, remove lockplate snap ring and lockplate. Remove canceling cam and upper bearing preload spring. Remove horn button components from canceling cam.

3) Remove hazard warning switch knob. Remove actuator arm attaching screw. Remove turn signal switch attaching screws. Unplug cruise control switch connector. Pull cruise control harness out of column. Turn ignition switch to ON position. Remove key warning buzzer switch and retainer.

4) Remove ignition lock cylinder retaining screw and pull out lock cylinder. Remove housing and shroud assembly. Ensure dimmer switch rod, lock pin or lock rack do not fall out of assembly. Pull turn signal/wiper lever straight out of column.

5) Remove wiper switch cover from back of housing and shroud assembly. Remove pivot screw from housing and remove switch. Install NEW switch and cover. Push on dimmer switch rod and position housing and shroud to column.

6) Ensure nylon spring retainer on lock pin is positioned forward of retaining slot of lock rack. Position first tooth of gear with forward tooth of lock rack.

7) Secure housing and shroud assembly. Insert key and lock cylinder. Ensure lock pin extends fully when key is moved to lock position. To install remaining components, reverse disassembly procedure. Tighten steering wheel nut to 25 ft. lbs. (34 N.m).

#### Removal & Installation (ZJ Models)

Turn ignition switch to OFF position. Remove 2 screws from back of steering wheel. Rock switch back and forth to remove switch from steering wheel. Disconnect cruise control switch connector. To install switch, reverse removal procedure.

## CONNECTOR IDENTIFICATION

### CONNECTOR IDENTIFICATION TABLE

Connector	Go To Figure:
Brakelight Switch .....	See Fig. 1
Clockspring Assembly .....	See Fig. 2
Cruise Control Servo .....	See Fig. 3
Cruise Control Switch (XJ Model) .....	See Fig. 4
Cruise Control Switch (ZJ Model) .....	See Fig. 5
Fuse Block .....	See Fig. 6
Powertrain Control Module (PCM) .....	See Fig. 7
Vehicle Speed Sensor .....	See Fig. 8

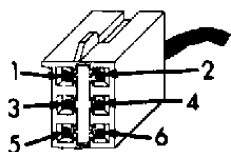


Fig. 1: Identifying Brakelight Switch Connector Terminals  
Courtesy of Chrysler Corp.

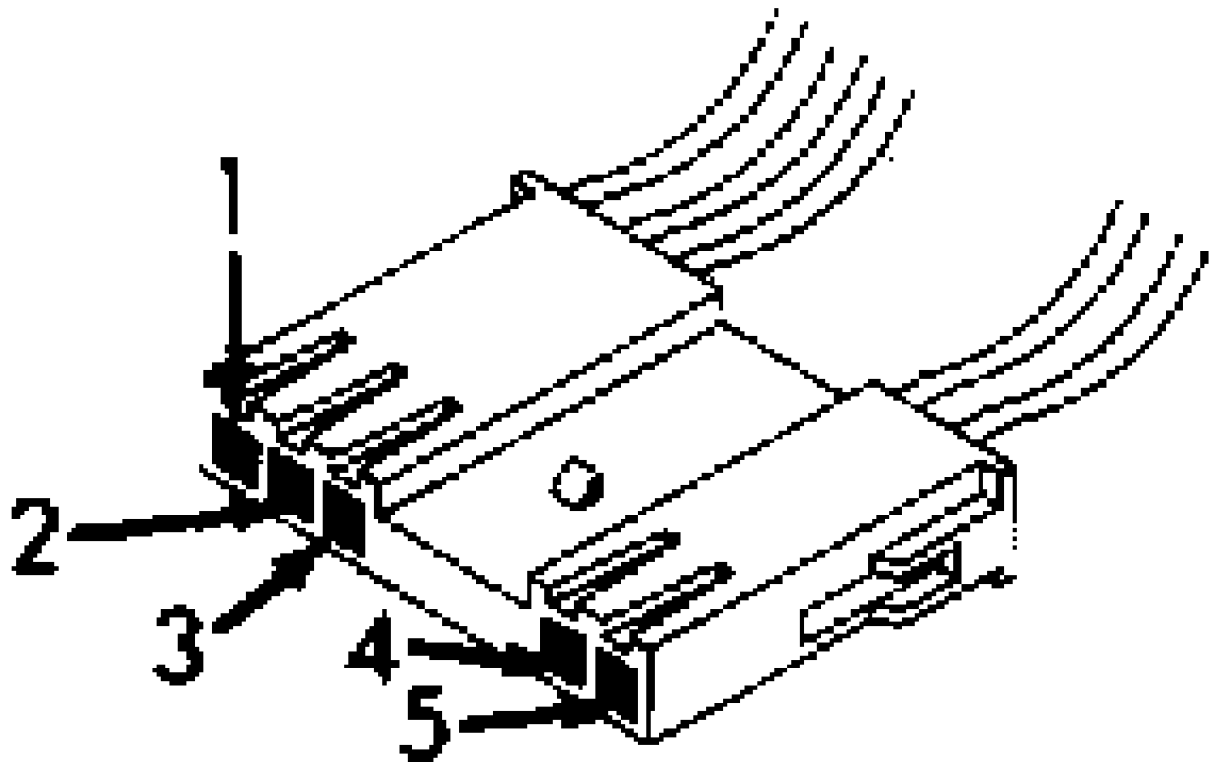


Fig. 2: Identifying Clockspring Connector Terminals  
 Courtesy of Chrysler Corp.

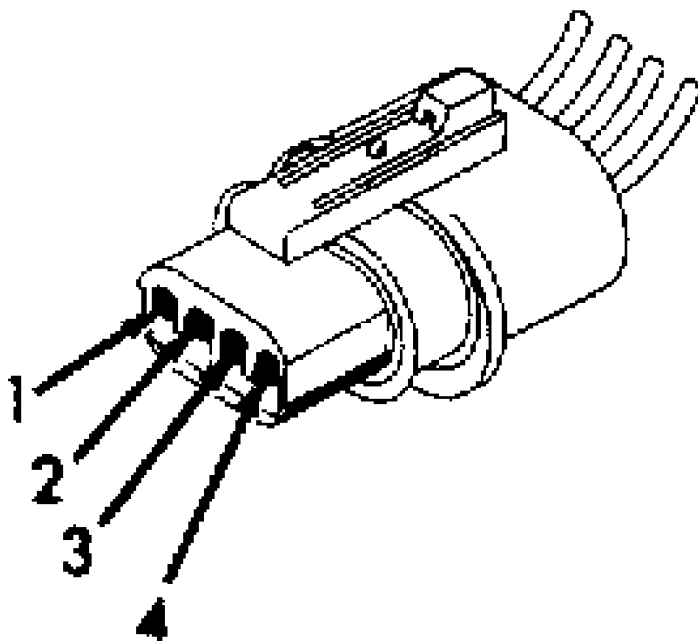
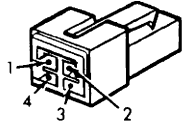


Fig. 3: Identifying Cruise Control Servo Connector Terminals  
 Courtesy of Chrysler Corp.



93J76081

Fig. 4: Cruise Control Switch Connector Terminal ID (XJ Model)  
Courtesy of Chrysler Corp.

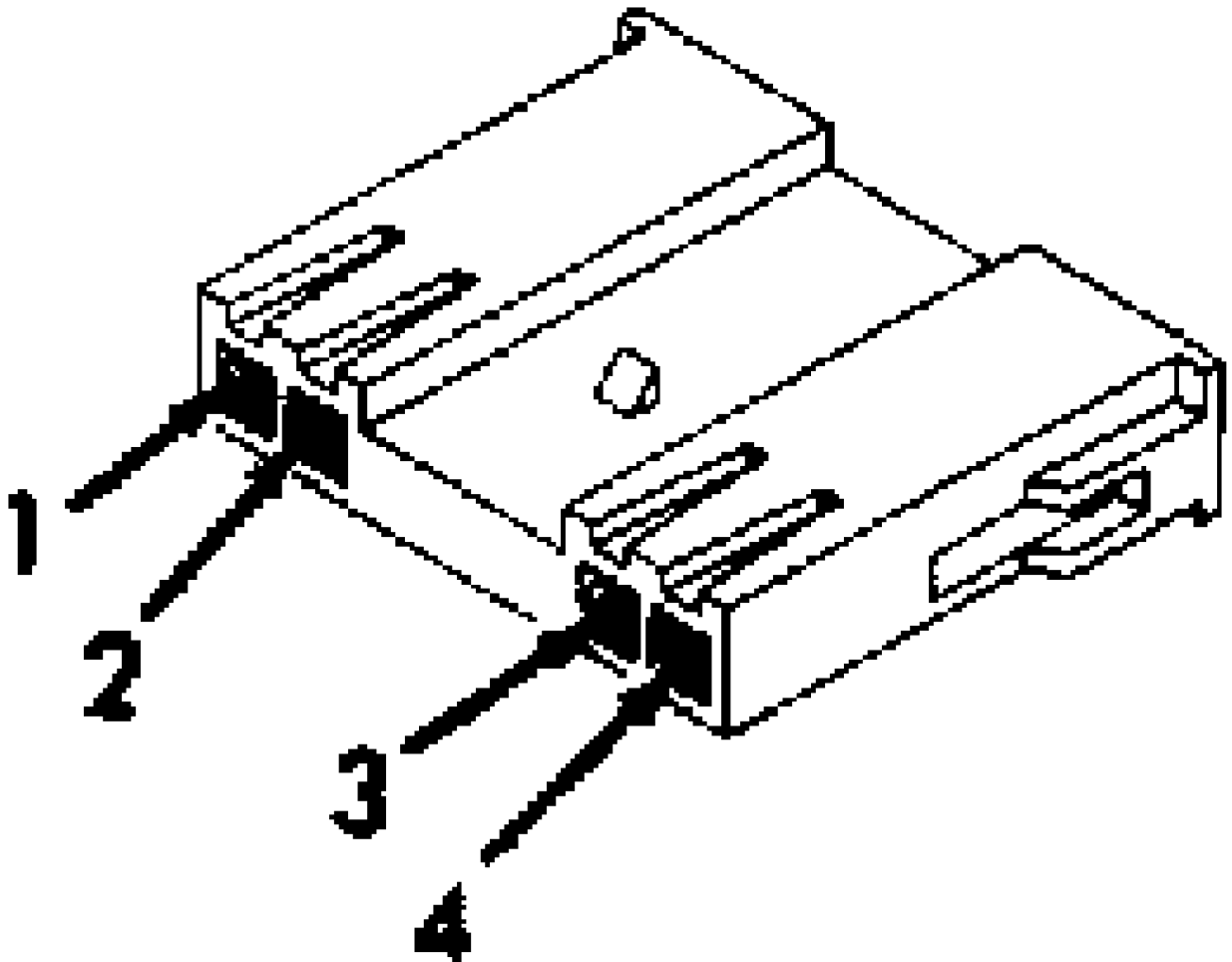
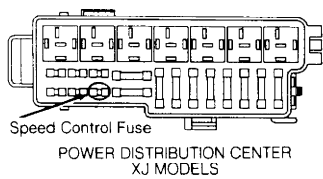
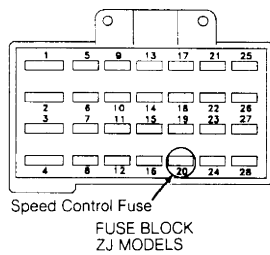


Fig. 5: Cruise Control Switch Connector Terminal ID (ZJ Model)  
Courtesy of Chrysler Corp.



93J76082

Fig. 6: Identifying Power Distribution Center (XJ Models)  
Courtesy of Chrysler Corp.



93A76083

Fig. 7: Identifying Fuse Block (ZJ Models)  
Courtesy of Chrysler Corp.

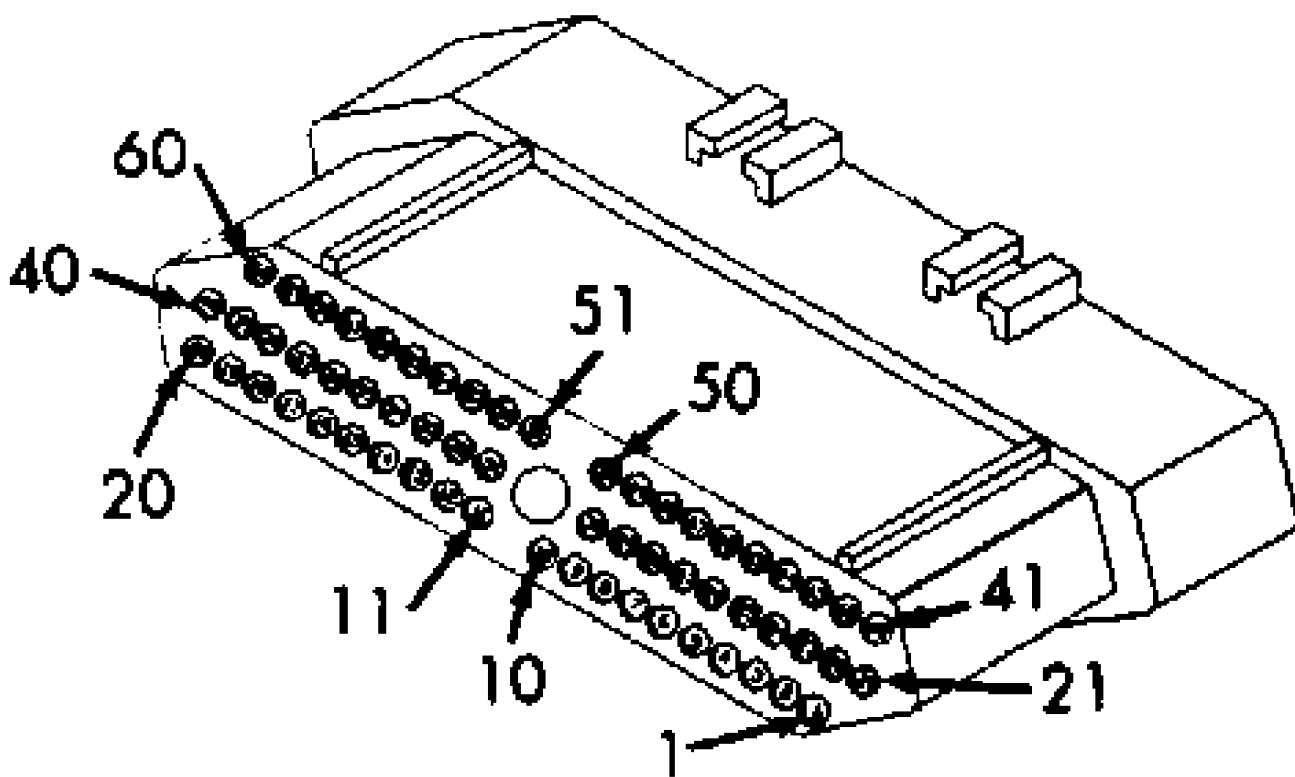


Fig. 8: Powertrain Control Module (PCM) Connector Terminal ID  
Courtesy of Chrysler Corp.

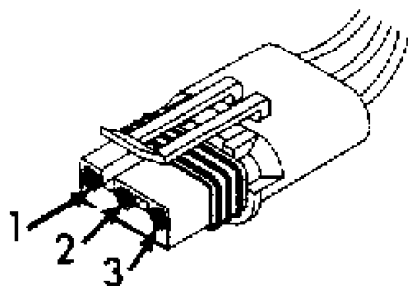


Fig. 9: Identifying Vehicle Speed Sensor Connector Terminals  
Courtesy of Chrysler Corp.

## SELF-DIAGNOSTICS

**\* PLEASE READ THIS FIRST \***

**WARNING:** If vehicle is equipped with air bag, air bag must be deactivated before servicing cruise control components on or around steering column.

**CAUTION:** Always turn ignition switch to OFF position before disconnecting or connecting any module connector.

**NOTE:** In following self-diagnostic tests, illustrations are courtesy of Chrysler Corp. For connector terminal identification, see CONNECTOR IDENTIFICATION. For appropriate wiring diagrams, see WIRING DIAGRAM.

**TEST SC-1A - CHECKING FOR CRUISE CONTROL SYSTEM FAULTS**

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Ensure battery is fully charged. With engine off, turn ignition switch to ON position. Using DRB-II, read fault messages.

2) If the DRB-II displays SPEED CONTROL SOLENOID CIRCUIT, proceed to TEST SC-2A. If DRB-II displays NO VEHICLE SPEED SENSOR SIGNAL, go to TEST SC-3A. If DRB-II does not display any fault messages, proceed to TEST SC-4A.

**TEST SC-2A - REPAIRING POWER & GROUND SUPPLY FOR OPEN TO SERVO SOLENOIDS**

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) While listening to cruise control servo, cycle cruise control ON/OFF switch. If cruise control servo clicks when cycling ON/OFF switch, go to TEST SC-2B. If cruise control servo does not click when cycling ON/OFF switch, disconnect cruise control servo connector. Inspect connector and clean and repair as needed.

2) Place cruise control ON/OFF switch in ON position. Ensure brake pedal is not depressed during following step. Using DRB-II in voltmeter mode, check cruise control solenoid feed voltage at terminal No. 2 (Dark Blue/Red wire) of cruise control servo connector.

3) If voltage is more than 10 volts, check ground circuit resistance at cruise control servo connector terminal No. 1 (Black wire) using DRB-II in ohmmeter mode. If resistance is less than 5 ohms, replace speed control servo. Perform TEST SC-VER. If resistance is more than 5 ohms, repair open system ground (Black) wire to cruise control servo. Perform TEST SC-VER.

4) If cruise control solenoid feed voltage is less than 10 volts, backprobe (with connector connected) brake switch connector at terminal No. 4, (Dark Blue/Red wire on XJ, Dark Blue/Light Blue wire on ZJ) of solenoid feed circuit. Ensure brake pedal is not depressed. DO NOT disconnect brake switch connector. If voltage is more than 10 volts, repair open in Dark Blue/Red wire between cruise control servo and brake switch. Perform TEST SC-VER.

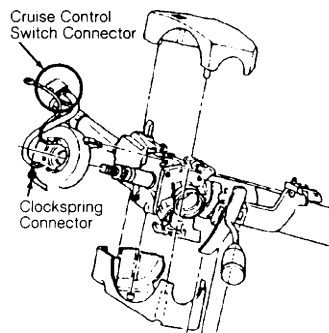
5) If voltage is less than 10 volts, backprobe (with connector connected) ON/OFF switch sense circuit at brake switch connector terminal No. 5 (Yellow/Red wire) using DRB-II. If voltage is more than 10 volts, adjust or replace brake switch as necessary.

Perform TEST SC-VER. If voltage is less than 10 volts, repair open cruise control ON/OFF switch sense circuit (Yellow/Red wire) on XJ models.

6) On ZJ models, remove steering column covers to gain access to cruise control switch connector. Using DRB-II in voltmeter mode, backprobe (with connector connected) ON/OFF switch sense circuit at cruise control switch connector terminal No. 3 (White wire). If voltage is less than 10 volts, replace cruise control switch. Perform TEST SC-VER.

7) If voltage is more than 10 volts, backprobe (with connector connected) ignition 12-volt feed circuit at clockspring connector terminal No. 2 (Yellow/Red wire) using DRB-II. See Fig. 10. DO NOT disconnect clockspring connector.

8) If voltage is less than 10 volts, replace clockspring assembly. See Fig. 10. Perform TEST SC-VER. If voltage is more than 10 volts, repair open cruise control ON/OFF switch sense circuit (Yellow/Red wire) between the clockspring and the brake switch. Perform TEST SC-VER.



93E75931

Fig. 10: Identifying Clockspring Assembly Location

## TEST SC-2B - CRUISE CONTROL VACUUM SOLENOID CONTROL CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition switch to OFF position. Disconnect Powertrain Control Module (PCM) connector. Inspect connector and clean and repair as needed. Turn ignition switch to ON position.

2) Place cruise control ON/OFF switch in ON position. Using DRB-II in voltmeter mode, check vacuum solenoid control circuit voltage at PCM connector terminal No. 33 (Tan/Red wire). If voltage is more than 10 volts, go to TEST SC-2C. If voltage is less than 10 volts, disconnect cruise control servo connector. Inspect connector and clean and repair as needed.

3) Using DRB-II in ohmmeter mode, check vacuum solenoid control circuit resistance at cruise control servo connector terminal No. 4 (Tan/Red wire). If resistance is less than 5 ohms, repair short to ground in Tan/Red wire. Perform TEST SC-VER.

4) If resistance is more than 5 ohms, check resistance between terminal No. 33 of PCM connector and terminal No. 4 of cruise control servo connector using external ohmmeter. Both have Tan/Red wire.

5) If resistance is less than 5 ohms, replace cruise control servo. Perform TEST SC-VER. If resistance is more than 5 ohms, repair open cruise control vacuum solenoid control (Tan/Red wire) circuit. Perform TEST SC-VER.

## TEST SC-2C - CRUISE CONTROL VENT SOLENOID CONTROL CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Using DRB-II in voltmeter mode, check vent solenoid control circuit voltage at terminal No. 53 (Light Green/Red wire) of Powertrain Control Module (PCM). If voltage is more than 10 volts, replace PCM. Perform TEST SC-VER. If voltage is less than 10 volts, disconnect cruise control servo connector. Inspect connector and clean and repair as needed.

2) Using DRB-II in ohmmeter mode, check vent solenoid control circuit resistance at cruise control servo connector terminal No. 3 (Light Green/Red wire). If resistance is less than 5 ohms, repair short to ground in Light Green/Red wire. Perform TEST SC-VER.

3) If resistance is more than 5 ohms, check vent solenoid control circuit resistance between PCM connector terminal No. 53 (Light Green/Red wire) and cruise control servo connector terminal No. 3 using an external ohmmeter. If resistance is less than 5 ohms, replace cruise control servo. Perform TEST SC-VER. If resistance is more than 5 ohms, repair open in the Light Green/Red wire. Perform TEST SC-VER.

## TEST SC-3A - NO VEHICLE SPEED SENSOR SIGNAL

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Raise and support vehicle. Start engine. Using DRB-II, read Vehicle Speed Sensor (VSS) signal. Shift transmission into any forward gear. If DRB-II does not display more than zero MPH, check if vehicle is equipped with electronic automatic transmission (EATX). If vehicle is equipped with electronic automatic transmission, go to TEST SC-3B.

2) If vehicle is not equipped with electronic automatic transmission, inspect quantity of wires attached to speed sensor connector. If speed sensor has 3 wire connector, go to TEST SC-3C. If speed sensor has 2 wire connector, go to TEST SC-3E.

3) If DRB-II displays more than zero MPH in 1), the condition required to set fault is not present at this time. The vehicle speed sensor signal fault sets if PCM does not see a VSS signal at PCM terminal No. 47 (White/Orange wire) for 11 seconds under road load conditions. Possible causes are open or shorted VSS signal circuit (White/Orange wire), failed VSS or open VSS 8-volt feed circuit (Orange wire) (without electronic automatic transmission), or failed Transmission Control Module (TCM) (with electronic automatic transmission).

4) Inspect all related wiring and connectors and repair as necessary. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION in the G - TESTS W/CODES - 2.5L & 4.0L article in the ENGINE PERFORMANCE Section. Perform TEST SC-VER. If it was necessary to repair related wiring and connectors, perform TEST SC-VER.

## TEST SC-3B - NO VEHICLE SPEED SENSOR SIGNAL

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram

in the WIRING DIAGRAMS section.

1) Using DRB-II, read electronic automatic transmission fault codes. If fault code(s) 50-58 is displayed, go to appropriate article in the TRANSMISSION SERVICE section. If fault code(s) 50-58 is not displayed, turn ignition switch to OFF position.

2) Disconnect Transmission Control Module (TCM) connector. Inspect connector and clean and repair as needed. Turn ignition switch to ON position. Using DRB-II in voltmeter mode, check Vehicle Speed Sensor (VSS) signal circuit at terminal No. 58 (White/Orange wire) of TCM connector.

3) If voltage is more than 4 volts, go to step 5). If voltage is less than 4 volts, turn ignition switch to OFF position. Disconnect PCM connector. Inspect connector and clean and repair as needed. Using an external ohmmeter, check VSS signal circuit resistance between terminal No. 58 (White/Orange wire) of TCM connector and PCM connector terminal No. 47.

4) If resistance is more than 5 ohms, repair open in White/Orange wire. Perform TEST SC-VER. If resistance is less than 5 ohms, place DRB-II in ohmmeter mode. Using DRB-II in ohmmeter mode, check VSS signal circuit resistance at PCM connector terminal No. 47 (White/Orange wire). If resistance is more than 5 ohms, replace PCM. Perform TEST SC-VER. If resistance is less than 5 ohms, repair short to ground in White/Orange wire. Perform TEST SC-VER.

5) Connect a jumper wire to TCM connector terminal No. 58, VSS signal circuit (White/Orange wire). Using DRB-II, monitor vehicle speed while tapping open end of jumper wire to ground. If DRB-II displays vehicle speed more than zero MPH, replace the TCM. Perform TEST SC-VER. If DRB-II does not display vehicle speed more than zero MPH, turn ignition switch to OFF position.

6) Disconnect and inspect PCM connector. Inspect connector and clean and repair as needed. Using external ohmmeter, check resistance of VSS signal circuit (White/Orange wire) between TCM connector terminal No. 58 and PCM connector terminal No. 47.

7) If resistance is less than 5 ohms, replace PCM. Perform TEST SC-VER. If resistance is more than 5 ohms, repair open in White/Orange wire. Perform TEST SC-VER.

## TEST SC-3C - NO VEHICLE SPEED SENSOR SIGNAL

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition switch to OFF position. Disconnect Vehicle Speed Sensor (VSS) connector. Inspect connector and clean and repair as needed. Turn ignition switch to ON position.

2) Using DRB-II in voltmeter mode, check 8-volt feed circuit voltage at terminal No. 3 (Orange wire) of VSS connector. If voltage is less than 7 volts, repair open in Orange wire. Perform TEST SC-VER.

3) If voltage is more than 7 volts, check VSS signal circuit voltage at terminal No. 1 (White/Orange wire) of VSS connector using DRB-II. If voltage is less than 4 volts, go to TEST SC-3D. If voltage is more than 4 volts, connect a jumper wire to VSS connector terminal No. 1 (White/Orange wire).

4) Using DRB-II, monitor vehicle speed while tapping open end of jumper wire to VSS ground circuit, connector terminal No. 2 (Black/Light Blue wire). If DRB-II displays vehicle speed more than zero MPH, replace VSS. Perform TEST SC-VER. If DRB-II does not display vehicle speed more than zero MPH, turn ignition switch to OFF position.

5) Using DRB-II in ohmmeter mode, check VSS ground circuit



resistance at terminal No. 2 (Black/Light Blue wire) of VSS connector. If resistance is more than 5 ohms, repair open in Black/Light Blue wire to harness splice. Perform TEST SC-VER. If resistance is less than 5 ohms, turn ignition switch to OFF position.

6) Disconnect PCM connector. Inspect connector and clean and repair as needed. Using external ohmmeter, check VSS signal circuit resistance at PCM connector terminal No. 47 (White/Orange wire).

7) If resistance is less than 5 ohms, replace PCM. Perform TEST SC-VER. If resistance is more than 5 ohms, repair open in White/Orange wire. Perform TEST SC-VER.

### TEST SC-3D - NO VEHICLE SPEED SENSOR SIGNAL

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition switch to OFF position. Disconnect PCM connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check Vehicle Speed Sensor (VSS) signal circuit resistance at PCM connector terminal No. 47, (White/Orange wire). If resistance is less than 5 ohms, repair short to ground in White/Orange wire. Perform TEST SC-VER.

2) If resistance is more than 5 ohms, check resistance of VSS signal circuit (White/Orange wire) between PCM connector terminal No. 47 and VSS connector terminal No. 1 using an external ohmmeter.

3) If resistance is less than 5 ohms, replace PCM. Perform TEST SC-VER. If resistance is more than 5 ohms, repair open in White/Orange wire. Perform TEST SC-VER.

### TEST SC-3E - NO VEHICLE SPEED SENSOR SIGNAL

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Ensure ignition is off. Disconnect VSS connector. Inspect connector and clean and repair as needed. Turn ignition on. Using DRB-II in voltmeter mode, check VSS signal at VSS connector terminal No. 1 (White/Orange wire). If voltage is less than 4 volts, go to TEST SC-3F.

2) If voltage is more than 4 volts, connect a jumper wire to VSS connector terminal No. 2 (Black/Light Blue wire). While observing DRB-II, tap open end of jumper wire on terminal No. 1 of VSS connector. If DRB-II displays more than zero MPH, replace VSS. Perform TEST SC-VER.

3) If DRB-II displays zero MPH readings, turn ignition off. Using DRB-II, check VSS ground circuit at terminal No. 2 (Black/Light Blue wire) of VSS connector. If resistance is greater than 5 ohms, repair sensor ground wire for open circuit to harness splice. If resistance is less than 5 ohms, go to TEST SC-3G.

### TEST SC-3F - NO VEHICLE SPEED SENSOR SIGNAL

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition off. Disconnect PCM connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter

mode, measure VSS signal resistance at terminal No. 47 (White/Orange wire) of PCM connector. If resistance is less than 5 ohms, repair VSS signal circuit for short to ground. Perform TEST SC-VER.

2) If resistance is more than 5 ohms, measure resistance between terminal No. 47 (White/Orange wire) of PCM connector and terminal No. 1 of VSS connector using external ohmmeter. If resistance is more than 5 ohms, repair open VSS signal wire. Perform TEST SC-VER. If resistance is less than 5 ohms, replace the PCM module. Perform TEST SC-VER.

## TEST SC-3G - NO VEHICLE SPEED SENSOR SIGNAL

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition off. Disconnect PCM connector. Inspect connector and clean and repair as needed. Using external ohmmeter, check VSS signal resistance between terminal No. 47 (White/Orange wire) of PCM connector and terminal No. 1 of VSS connector.

2) If resistance is more than 5 ohms, repair open speed sensor signal wire. Perform TEST SC-VER. If resistance is less than 5 ohms, replace PCM module. Perform TEST SC-VER.

## TEST SC-4A - CHECKING CRUISE CONTROL SWITCHES

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Using DRB-II, read cruise control inputs monitor. While watching cruise control ON/OFF input, cycle cruise control ON/OFF switch several times. If DRB-II display does not correspond with switch position, go to TEST SC-5A.

2) If DRB-II display does correspond with switch position, place cruise control ON/OFF switch in ON position. While watching RESUME input, cycle resume switch several times. If DRB-II display does not correspond with switch position, go to TEST SC-6A.

3) If DRB-II display does correspond with switch position, cycle SET switch several times while watching SET switch input. If DRB-II display does not correspond with switch position, proceed to TEST SC-7A. If DRB-II display does correspond with switch position, depress and release brake pedal several times while watching BRAKE pedal input.

4) If DRB-II display does not correspond with brake pedal position, go to TEST SC-10A. If DRB-II display does correspond with brake pedal position, check if vehicle is equipped with a manual transmission. If vehicle is equipped with manual transmission, go to TEST SC-11A.

5) If vehicle is not equipped with manual transmission, ensure ignition switch is in ON position. While watching P/N SWITCH input, cycle gear selector several times between "P", "R", "N" and "D". If DRB-II display does not correspond with selector position, go to TEST SC-12A. If DRB-II display does correspond with selector position, go to TEST SC-11A.

## TEST SC-5A - CHECKING CRUISE CONTROL ON/OFF SWITCH SENSE CKT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram

in the WIRING DIAGRAMS section.

1) Using DRB-II in voltmeter mode, check voltage at both sides of cruise control fuse. If voltage input side of fuse (Dark Blue wire) is less than 10 volts, repair open in Dark Blue wire to cruise control fuse. Perform TEST SC-VER.

2) If voltage input side of fuse (Dark Blue wire) is more than 10 volts, inspect speed control fuse. If fuse is good, go to step 4). If fuse is open (NG), disconnect cruise control switch connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check ignition 12-volt feed at cruise control switch connector terminal No. 2 (Dark Blue/White wire) on ZJ models, terminal No. 4 (Dark Blue/White wire) on XJ models.

3) If resistance is less than 5 ohms, go to TEST SC-5C. If resistance is more than 5 ohms, turn ignition off. On all models, disconnect PCM module. Inspect connector and clean and repair as needed. Go to TEST SC-5B.

4) Backprobe (with connector connected) ignition 12-volt feed circuit at cruise control switch connector terminal No. 2 (Dark Blue/White wire) on ZJ models, terminal No. 4 (Dark Blue/White wire) on XJ models using DRB-II in voltmeter mode.

5) If voltage is less than 10 volts, go to TEST SC-5D. If voltage is more than 10 volts, push cruise control switch to ON position. On all models, backprobe (with connector connected) cruise control ON/OFF switch sense circuit voltage at terminal No. 1 (Yellow/Red wire) of cruise control switch connector.

6) If voltage is less than 10 volts, replace cruise control switch. Perform TEST SC-VER. If voltage is more than 10 volts, turn ignition off. Disconnect PCM connector. Inspect connector and clean and repair as needed. Turn ignition on. Ensure cruise control is still in ON position.

7) Using DRB-II in voltmeter mode, check cruise control ON/OFF switch voltage at terminal No. 49 (Yellow/Red wire) of PCM connector. If voltage reads less than 10 volts, repair open in the cruise control ON/OFF switch sense wire to the PCM connector. Perform TEST SC-VER. If voltage reads more than 10 volts, replace the PCM module. Perform TEST SC-VER.

## TEST SC-5B - REPAIRING A SHORT IN SPEED CONTROL SWITCH CKTS

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Using DRB-II in ohmmeter mode, check cruise control set switch resistance at terminal No. 48 (Brown/Red wire) of PCM module. If resistance is less than 5 ohms, repair cruise control set switch sense circuit short to ground. Perform TEST SC-VER.

2) If resistance is more than 5 ohms, check cruise control resume sense circuit resistance at terminal No. 50 (White/Light Green wire) of PCM module using DRB-II in ohmmeter mode. If resistance is less than 5 ohms, repair cruise control resume switch sense circuit short to ground. Replace cruise control fuse. Perform TEST SC-VER.

3) If resistance is more than 5 ohms, check cruise control ON/OFF switch sense resistance at terminal No. 49 (Yellow/Red wire) of PCM connector using DRB-II in ohmmeter mode. If resistance is more than 5 ohms, replace PCM module. Replace cruise control fuse. Perform TEST SC-VER.

4) If resistance is less than 5 ohms, disconnect brake switch connector. Inspect connector and clean and repair as needed. Check cruise control ON/OFF switch sense resistance at terminal No. 49 (Yellow/Red wire) of PCM module connector. If resistance is less than

5 ohms, repair cruise control ON/OFF switch sense circuit short to ground. Replace cruise control fuse. Perform TEST SC-VER.

5) If resistance is more than 5 ohms, check cruise control ON/OFF switch sense resistance at terminal No. 1 (Yellow/Red wire) of brake switch connector output. If resistance is more than 5 ohms, replace brake switch. Replace cruise control fuse. Perform TEST SC-VER.

6) If resistance is less than 5 ohms, disconnect cruise control servo connector. Using DRB-II in ohmmeter mode, check cruise control ON/OFF switch sense circuit resistance at terminal No. 2 of servo connector.

7) If resistance is more than 5 ohms, replace cruise control servo. Replace cruise control fuse. Perform TEST SC-VER. If resistance is less than 5 ohms, repair cruise control ON/OFF switch sense circuit short to ground. Replace cruise control fuse. Perform TEST SC-VER.

### TEST SC-5C - REPAIRING SHORT IN IGNITION 12 VOLT FEED CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) On XJ models, repair ignition 12-volt feed circuit to cruise control switch for a short to ground. Replace cruise control fuse. Perform TEST SC-VER. On ZJ models, disconnect clockspring connector. See Fig. 10 in TEST SC-2A. Using DRB-II in ohmmeter mode, check ignition 12-volt feed circuit at terminal No. 3 (White/Red wire) of clockspring connector.

2) If resistance is below 5 ohms, repair ignition 12-volt feed circuit short to ground. Replace cruise control fuse. Perform TEST SC-VER. If resistance is more than 5 ohms, replace clockspring assembly. Replace cruise control fuse. Perform TEST SC-VER.

### TEST SC-5D - REPAIRING OPEN IN IGNITION 12 VOLT FEED CIRCUIT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) On XJ models, repair open 12-volt feed fuse to cruise control switch circuit. Perform TEST SC-VER. On ZJ models, disconnect clockspring connector. See Fig. 10 in TEST SC-2A. Using DRB-II in voltmeter mode, check ignition 12-volt feed circuit voltage at terminal No. 3 (White/Red wire) of clockspring connector.

2) If voltage is more than 10 volts, replace clockspring assembly. Perform TEST SC-VER. If voltage is less than 10 volts, repair open ignition 12-volt feed clockspring to fuse block circuit. Perform TEST SC-VER.

### TEST SC-6A - REPAIRING CRUISE CONTROL RESUME SWITCH SENSE CKT

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition switch to OFF position. Disconnect PCM module connector. Inspect connector and clean and repair as needed. Turn ignition on. Using DRB-II in voltmeter mode, check cruise control resume sense circuit voltage at terminal No. 1 (White/Light Green wire) of PCM module connector.

2) If voltage is more than 10 volts, replace cruise control switch. Perform TEST SC-VER. If voltage is less than 10 volts, determine if vehicle is XJ or ZJ model. If vehicle is XJ model, go to step 6). If vehicle is ZJ model, backprobe (with connector connected) resume switch sense circuit voltage at terminal No. 3 (White wire) of cruise control switch connector.

3) Hold down resume switch button. If voltage is less than 10 volts, replace cruise control switch. Perform TEST SC-VER. Release resume switch button. If voltage is more than 10 volts, backprobe (with connector connected) cruise control resume switch sense circuit voltage at terminal No. 2 (White/Light Green wire) of output side of clockspring connector using DRB-II in voltmeter mode. See Fig. 10 in TEST SC-2A.

4) Hold down resume switch button. If voltage is less than 10 volts, replace clockspring assembly. Perform TEST SC-VER. Release resume switch button. Check cruise control resume sense circuit voltage at terminal No. 50 (White/Light Green wire) of PCM module connector. Hold down resume switch button.

5) If voltage is less than 10 volts, repair open cruise control resume sense circuit between clockspring and PCM module. Perform TEST SC-VER. If voltage is more than 10 volts, replace PCM module. Perform TEST SC-VER.

6) On XJ models, backprobe (with connector connected) cruise control resume switch sense circuit voltage at terminal No. 2 (White/Light Green wire) of cruise control switch connector using DRB-II in voltmeter mode. Hold down resume switch button. If voltage is less than 10 volts, replace cruise control switch. If voltage is more than 10 volts, release resume switch button.

7) Check cruise control resume sense circuit voltage at terminal No. 50 (White/Light Green wire) of PCM module connector. Hold down resume switch button. If voltage is less than 10 volts, repair open cruise control resume switch sense circuit between switch and PCM module. Perform TEST SC-VER. If voltage is more than 10 volts, replace PCM module. Perform TEST SC-VER.

## TEST SC-7A - REPAIRING CRUISE CONTROL SET SWITCH CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Turn ignition switch to OFF position. On XJ models go to step 6). On ZJ models, disconnect PCM module. Inspect connector and clean and repair as needed. Turn ignition on. Ensure cruise control switch is in ON position. Using DRB-II in voltmeter mode, backprobe (with connector connected) cruise control set switch sense circuit voltage at terminal No. 4 (Brown/Red wire) of switch connector.

2) If voltage is less than 10 volts, replace cruise control switch. Perform TEST SC-VER. If voltage is more than 10 volts, backprobe (with connector connected) cruise control set switch sense circuit at terminal No. 4 (Brown/Red wire) of clockspring connector using DRB-II in voltmeter mode. See Fig. 10 in TEST SC-2A.

3) If voltage is less than 10 volts, replace clockspring assembly. Perform TEST SC-VER. If voltage is more than 10 volts, check cruise control set switch sense circuit voltage at terminal No. 48 (Brown/Red wire) of PCM connector.

4) If voltage is less than 10 volts, repair open cruise control set switch sense circuit between switch and PCM. If voltage is more than 10 volts, hold set switch in ON position.

5) Check cruise control set switch sense circuit voltage at terminal No. 48 (Brown/Red wire) of PCM connector. If voltage is more than 10 volts, replace cruise control switch. Perform TEST SC-VER. If

voltage measures less than 10 volts, replace the PCM module. Perform TEST SC-VER.

6) Disconnect PCM module. Inspect connector and clean and repair as needed. Turn ignition on. Using DRB-II in voltmeter mode, check cruise control set switch sense circuit voltage at terminal No. 48 (Brown/Red wire) of PCM connector. If voltage is more than 10 volts, replace cruise control switch. Perform TEST SC-VER.

7) If voltage is less than 10 volts, hold set switch button in ON position. Backprobe (with connector connected) cruise control set switch sense circuit voltage at terminal No. 3 (Brown/Red wire) of cruise control switch connector. If voltage is less than 10 volts, replace cruise control switch. Perform TEST SC-VER.

8) If voltage is more than 10 volts, check cruise control set switch sense circuit voltage at terminal No. 48 (Brown/Red wire) of PCM connector. Continue to hold down set switch button. If voltage is less than 10 volts, repair open cruise control set switch sense circuit between switch and PCM. Perform TEST SC-VER. If voltage is more than 10 volts, replace PCM module. Perform TEST SC-VER.

## TEST SC-8A - CHECKING CRUISE CONTROL SWITCH CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Inspect cruise control fuse. If fuse is okay, go to step 4). If fuse is open (NG), disconnect cruise control switch connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check cruise control ON/OFF switch sense circuit resistance at terminal No. 3 (White wire) of switch connector.

2) If resistance is more than 5 ohms, go to TEST SC-9A. If resistance is less than 5 ohms, disconnect clockspring. See Fig. 10 in TEST SC-2A. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check ignition 12-volt feed circuit resistance at terminal No. 5 (White/Red wire) of clockspring connector.

3) If resistance is more than 5 ohms, replace clockspring. Perform TEST SC-VER. Replace cruise control fuse. If resistance is less than 5 ohms, repair short to ground in White/Red wire. Perform TEST SC-VER. Replace cruise control fuse.

4) Using DRB-II in voltmeter mode, backprobe (with connector connected) ignition 12-volt feed circuit at terminal No. 1 (Yellow/Red wire) of cruise control switch connector. If voltage is more than 10 volts, go to step 6). If voltage is less than 10 volts, using DRB-II, backprobe (with connector connected) ignition 12-volt feed circuit at terminal No. 5 (White/Red wire) at clockspring connector.

5) If voltage is more than 10 volts, replace clockspring. See Fig. 10 in TEST SC-2A. Perform TEST SC-VER. If voltage is less than 10 volts, repair open in the White/Red wire to the fuse panel. Perform TEST SC-VER.

6) Turn ignition switch to OFF position. Disconnect PCM connector. Perform TEST SC-VER. Turn ignition switch to ON position. Place cruise control ON/OFF switch in ON position. Using DRB-II in voltmeter mode, backprobe (with connector connected) cruise control mode select sense circuit voltage at No. 4 (Brown/Red wire) of switch connector.

7) If voltage is less than 10 volts, go to TEST SC-8B. If voltage is more than 10 volts, check cruise control mode select sense circuit voltage at terminal No. 23 (Red/Light Green wire) at PCM connector. If voltage is less than 10 volts, go to TEST SC-8C.

8) If voltage is more than 10 volts, disconnect cruise control switch connector. Using external ohmmeter, check resistance

between cruise control switch connector terminal No. 1 (Yellow/Red wire) and terminal No. 4 (Brown/Red wire). If resistance is 5890-6510 ohms, replace PCM. Perform TEST SC-VER. If resistance is not 5890-6510 ohms, replace cruise control switch. Perform TEST SC-VER.

## TEST SC-8B - TESTING CLOCKSPRING CIRCUIT FOR SHORTS

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect cruise control switch connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check mode select sense circuit resistance at terminal No. 23 (Red/Light Green wire) of PCM connector.

2) If resistance is more than 5 ohms, replace cruise control switch. Perform TEST SC-VER. If resistance is less than 5 ohms, disconnect clockspring connector. See Fig. 10 in TEST SC-2A. Inspect connector and clean and repair as needed.

3) Using DRB-II, check mode select sense circuit (Red/Light Green wire) resistance at terminal No. 23 (Red/Light Green wire) of PCM connector. If resistance is more than 5 ohms, replace clockspring assembly. Perform TEST SC-VER. If resistance is less than 5 ohms, repair short to ground in Red/Light Green wire. Perform TEST SC-VER.

## TEST SC-8C - TESTING CLOCKSPRING CIRCUIT FOR OPEN

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

Using DRB-II, backprobe (with connector connected) mode select sense circuit at terminal No. 4 (Red/Light Green wire) of clockspring connector. See Fig. 10 in TEST SC-2A. If voltage is less than 10 volts, replace clockspring assembly. Perform TEST SC-VER. If voltage is more than 10 volts, repair open in Red/Light Green wire. Perform TEST SC-VER.

## TEST SC-9A - REPAIRING CRUISE CONTROL SWITCH CKT SHORT TO GND

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect cruise control servo connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check on/off switch sense circuit resistance at terminal No. 1 (Yellow/Red wire) of switch connector on ZJ models. On XJ models, check resistance at terminal No. 3 (White wire) of switch connector.

2) On all models, if resistance is more than 5 ohms, replace cruise control servo. Replace cruise control fuse. Perform TEST SC-VER. If resistance is less than 5 ohms, disconnect brake switch connector. Inspect connector and clean and repair as needed.

3) Using DRB-II in ohmmeter mode, check on/off switch sense circuit resistance at terminal No. 1 (Yellow/Red wire) of switch connector on ZJ models. On XJ models, check resistance at terminal No. 3 (White wire) of switch connector. On all models, if resistance is less than 5 ohms, go to step 5). If resistance is more than 5 ohms, check cruise control ON/OFF switch sense circuit resistance at terminal No. 1 (Yellow/Red wire) of brake switch connector.

4) If resistance is less than 5 ohms, repair ON/OFF switch sense circuit for short to ground between brake switch and servo. Replace cruise control fuse. Perform TEST SC-VER. If resistance is more than 5 ohms, replace brake switch. Replace cruise control fuse. Perform TEST SC-VER.

5) Disconnect clockspring connector. See Fig. 10 in TEST SC-2A. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check cruise control ON/OFF switch sense circuit resistance at terminal No. 1 (Yellow/Red wire) of brake switch connector input.

6) If resistance is more than 5 ohms, replace clockspring assembly. Replace cruise control fuse. Perform TEST SC-VER. If resistance is less than 5 ohms, repair ON/OFF switch sense circuit for short to ground. Perform TEST SC-VER.

## TEST SC-10A - CHECKING BRAKE SWITCH CIRCUIT FOR OPEN

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) If DRB-II displays RELEASED at all times, go to TEST SC-10B. If DRB-II does not display RELEASED at all times, disconnect brake switch. Inspect connector and clean and repair as needed.

2) Connect a jumper wire between terminal No. 3 (White/Pink wire on XJ, Brown wire on ZJ) and terminal No. 6 (Black wire). Using DRB-II, read cruise control inputs monitor. If DRB-II does not display RELEASED, go to step 4).

3) If DRB-II displays RELEASED, check brake switch adjustment. If brake switch is adjusted correctly, replace brake switch. Perform TEST SC-VER. If brake switch is not adjusted correctly, adjust brake switch. Perform TEST SC-VER.

4) Connect jumper wire between brake switch connector terminal No. 3 and ground. Using DRB-II, read cruise control inputs monitor. If DRB-II displays RELEASED, repair open in Black wire to brake switch. If DRB-II does not display RELEASED, turn ignition switch to OFF position. Remove jumper wire. Disconnect PCM connector. Inspect connector and clean and repair as needed.

5) Check brake switch sense circuit resistance between terminal No. 3 (White/Pink wire on XJ, Brown wire on ZJ) of brake switch connector and terminal No. 29 of PCM connector using an external ohmmeter.

6) If resistance is more than 5 ohms, repair open White/Pink or Brown wire between brake switch and PCM. Perform TEST SC-VER. If resistance is less than 5 ohms, replace PCM. Perform TEST SC-VER.

## TEST SC-10B - CHECKING BRAKE SWITCH CIRCUIT FOR SHORTS

**NOTE:** For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect brake switch connector. Inspect connector and clean and repair as needed. Using DRB-II, read cruise control inputs monitor. If DRB-II displays PRESSED, go to step 3). If DRB-II does not display PRESSED, turn ignition switch to OFF position. Disconnect PCM connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check brake switch sense circuit resistance at terminal No. 29 (White/Pink on XJ, Brown wire on ZJ) of PCM connector.

2) If resistance is less than 5 ohms, repair short to ground



in White/Pink or Brown wire between the brake switch and the PCM. Perform TEST SC-VER. If resistance is more than 5 ohms, replace PCM. Perform TEST SC-VER.

3) Check brake switch adjustment. If brake switch is adjusted correctly, replace brake switch. Perform TEST SC-VER. If brake switch is not adjusted correctly, adjust brake switch. Perform TEST SC-VER.

## TEST SC-11A - CHECKING CRUISE CONTROL SERVO OPERATION

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect cruise control servo connector. Inspect connector and clean and repair as needed. Using DRB-II in ohmmeter mode, check ground circuit resistance at terminal No. 1 (Black wire) of cruise control servo connector.

2) If resistance is more than 5 ohms, repair open Black wire to cruise control servo. Perform TEST SC-VER. If resistance is less than 5 ohms, connect cruise control servo connector. Check if vehicle is equipped with a vacuum reservoir. If vehicle is equipped with vacuum reservoir, go to TEST SC-11B.

3) If vehicle is not equipped with a vacuum reservoir, disconnect cruise control servo vacuum hose. Connect vacuum gauge to servo vacuum hose. Start engine. If gauge does not read at least 10 in. Hg of vacuum, repair vacuum leak or restriction between servo and vacuum source. Perform TEST SC-VER.

4) If gauge reads at least 10 in. Hg of vacuum, turn engine off. Turn ignition switch to ON position. Press cruise control ON/OFF switch to ON position. Using an alternative source of constant vacuum feed, connect vacuum feed to servo. Using DRB-II, actuate servo solenoids. If throttle fully opens and closes, go to TEST SC-13A.

5) If throttle does not fully open and close, stop actuation test. Inspect cruise control servo cable condition. If cruise control servo cable is okay, replace cruise control servo. Perform TEST SC-VER. If cruise control servo cable is not okay, repair or adjust cable as necessary. Perform TEST SC-VER.

## TEST SC-11B - CHECKING VACUUM TO CRUISE CONTROL SERVO

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Start engine. Turn engine off. Turn ignition switch to ON position. Using DRB-II, actuate servo solenoids. If throttle fully opens and closes, go to TEST SC-13A. If throttle does not fully open and close, stop actuation test.

2) Disconnect vacuum hose at cruise control servo. Using an alternative source of constant vacuum feed, connect vacuum feed to servo. Using DRB-II, actuate servo solenoids. If throttle fully opens and closes, repair vacuum leak or restriction between servo and vacuum source. Perform TEST SC-VER.

3) If throttle does not fully open and close, stop actuation test. Inspect cruise control servo cable. If cruise control servo cable is okay, replace cruise control servo. Perform TEST SC-VER. If cruise control servo cable is not okay, repair or adjust cable as necessary. Perform TEST SC-VER.

## TEST SC-12A - CHECKING PARK/NEUTRAL SWITCH CIRCUIT

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Disconnect Park/Neutral switch connector at transmission. Inspect connector and clean and repair as needed. Using DRB-II, read cruise control inputs monitor.

2) If DRB-II displays D/R, replace Park/Neutral switch. Perform TEST SC-VER. If DRB-II does not display D/R, turn ignition switch to OFF position. Disconnect PCM connector. Inspect connector and clean and repair as needed.

3) Using DRB-II in ohmmeter mode, check park/neutral switch sense circuit resistance at terminal No. 30 (Brown/Yellow wire on XJ, Brown/White wire on ZJ) of PCM connector. If resistance is less than 5 ohms, repair short to ground in wire. Perform TEST SC-VER. If resistance is more than 5 ohms, replace PCM. Perform TEST SC-VER.

## TEST SC-13A - CHECKING FOR INTERMITTENT FAULTS

NOTE: For connector terminal identification, refer to the CONNECTOR IDENTIFICATION table. For appropriate wiring diagram, see appropriate chassis wiring diagram in the WIRING DIAGRAMS section.

1) Reconnect and reassemble all previously tested components. Connect DRB-II to engine diagnostic connector so DRB-II display can be seen from driver's seat. Road test vehicle. Using DRB-II, read CUTOUT monitor on DRB-II display. If DRB-II display shows erratic vehicle speed, replace vehicle speed sensor. Perform TEST SC-VER.

2) If DRB-II does not display erratic vehicle speed, Place cruise control ON/OFF switch in ON position. With vehicle speed at a minimum of 35 MPH, press and release cruise control SET/DECEL switch. If DRB-II displays S/C ALLOWED and cruise control is inoperative, repair cruise control servo vacuum feed or mechanical problems as necessary. Perform TEST SC-VER. If DRB-II displays S/C ALLOWED and cruise control is operative, perform following:

- \* Check for cruise control disengagement without driver command by driving vehicle under various road conditions.
- \* If cruise control disengages without driver command, using DRB-II, read CUTOUT monitor S/C DENIED message. See appropriate DENIED MESSAGE in DRB-II INTERMITTENT FAULT MESSAGES table and correct problem as necessary. Perform TEST SC-VER.
- \* If cruise control does not disengage without driver command, using DRB-II, read CUTOUT monitor. Compare GOAL value with SPEED value. If values are not within 2 MPH of each other, replace PCM. Perform TEST SC-VER. If values are within 2 MPH of each other, test is complete.

3) If DRB-II displays S/C DENIED, see appropriate DENIED MESSAGE in DRB-II INTERMITTENT FAULT MESSAGES table and correct problem as necessary.

### DRB-II INTERMITTENT FAULT MESSAGES TABLE

Denied Message	Problem To Correct
BRAKE .....	Open Circuit At PCM Terminal No. 29
CLUTCH .....	RPM/Vehicle Speed Ratio Is Not Constant
ON/OFF .....	Lack Of Voltage At PCM Terminal No. 23
P/N .....	Open Circuit At PCM Terminal No. 30

RPM/SPD	.....	RPM/Vehicle Speed Ratio Is Not Constant
SPEED	.....	Vehicle Speed As Read By Vehicle
"	.....	Speed Sensor Is Less Than 35 MPH
RPM	.....	Engine RPM Is Excessively High
SOL/FLT	.....	Fault In Servo Vent Or Vacuum Solenoid
"	.....	Circuit That Is Either Maturing Or Set

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## TEST SC-VER - CRUISE CONTROL VERIFICATION

Reconnect and reassemble all previously tested components. If PCM has been changed, and vehicle is equipped with factory theft alarm, start vehicle at least 20 times so alarm system may be activated when desired. Connect DRB-II to engine diagnostic connector and erase faults. To ensure no other fault remains, perform following:

1) Road test vehicle at a speed above 35 MPH. Place cruise control ON/OFF switch in the ON position. Press and release the SET/DECEL switch. If cruise control does not engage, repair is not complete. Check all related TECHNICAL SERVICE BULLETINS and return to TEST SC-1A as necessary.

2) Press and release RESUME/ACCEL switch. If vehicle speed does not increase by 2 MPH, repair is not complete. Check all related TECHNICAL SERVICE BULLETINS and return to TEST SC-1A as necessary.

3) Depress and release brake pedal. If cruise control does not disengage, repair is not complete. Check all related TECHNICAL SERVICE BULLETINS and return to TEST SC-1A as necessary.

4) Increase vehicle speed to 35 MPH. Press RESUME/ACCEL switch. If cruise control does not resume previously set speed, repair is not complete. Check all related TECHNICAL SERVICE BULLETINS and return to TEST SC-1A, as necessary.

5) Hold down SET/DECEL switch. If vehicle does not decelerate, repair is not complete. Check all related TECHNICAL SERVICE BULLETINS and return to TEST SC-1A as necessary.

6) Ensure vehicle speed is greater than 35 MPH and release SET/DECEL switch. If vehicle does not adjust to new vehicle speed, repair is not complete. Check all related TECHNICAL SERVICE BULLETINS and return to TEST SC-1A as necessary.

7) Place ON/OFF switch in OFF position. If cruise control does not disengage, repair is not complete. Check all related TECHNICAL SERVICE BULLETINS and return to TEST SC-1A as necessary.

8) If vehicle successfully passed all previous tests, cruise control system is now functioning correctly. Repair is complete.

## WIRING DIAGRAM

For wiring diagram, see appropriate chassis wiring diagram article in the WIRING DIAGRAMS section.

## **D - ADJUSTMENTS**

### **1993 Jeep Cherokee**

1993 ENGINE PERFORMANCE  
Chrysler Corp. On-Vehicle Adjustments

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

#### **ENGINE MECHANICAL**

Before performing any on-vehicle adjustments to fuel or ignition systems, ensure engine mechanical condition is okay.

#### **VALVE CLEARANCE**

All models are equipped with hydraulic valve lifters. No adjustments are required.

#### **IGNITION TIMING**

All Jeep vehicles are equipped with Powertrain Control Module (PCM) computerized ignition system. PCM controls ignition timing. Adjustment is not required or possible.

#### **IDLE SPEED & MIXTURE**

All Jeep vehicles are equipped with Powertrain Control Module computerized ignition system. PCM controls idle speed and air/fuel mixture. Adjustments are not required or possible.

#### **THROTTLE POSITION SENSOR (TPS)**

1) Turn ignition on. Check TPS output voltage at sensor wiring harness center terminal. At idle, output voltage should be greater than .2 volt.

2) Gradually open throttle plate. Output voltage should gradually increase as throttle plate is opened. At wide open throttle, output voltage must be less than 4.8 volts.

3) If voltages are not as specified, make sure 5-volt input and ground circuits between TPS and engine controller are okay. Repair circuits, if necessary. If TPS output voltages are still not as specified, replace TPS. Adjustment is not required or possible.

NOTE: Also see appropriate throttle position sensor tests in appropriate G - TESTS W/ CODES article.

# DEFOGGER - REAR WINDOW

## 1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Rear Window Defoggers

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION & OPERATION

System consists of 2 vertical bus bars and horizontal rows of heating elements fused to inside of rear glass. On Cherokee, power circuit to grid is protected by fuse No. 18 (25-amp) located in fuse box. Power for relay is protected by fuse No. 8 (20-amp) located in fuse box.

On Grand Cherokee and Grand Wagoneer, power circuit to grid is protected by circuit breaker No. 28 (30-amp) located in fuse box. Power for relay is protected by fuse No. 19 (15-amp) located in fuse box. Fuse No. 23, located in fuse box, controls power to switch light and side mirrors.

On Wrangler, power circuit to grid is protected by fuse No. 6 (25-amp) located in fuse box. Power for relay is protected by fuse No. 9 (15-amp) located in fuse box.

### TESTING

NOTE: For terminal identification, see appropriate chassis wiring in WIRING DIAGRAMS.

### SYSTEM TESTING

1) On Wrangler, check fuses No. 6 and 9. On Cherokee, check HTD/WDW and TURN fuses. On Grand Cherokee and Grand Wagoneer, check fuses No. 19 and 23 and circuit breaker No. 28. Replace as necessary.

2) If fuses are okay, check for voltage on battery side of fuse No. 6 (Wrangler), HTD/WDW fuse (Cherokee) or fuse No. 28 (Grand Cherokee and Grand Wagoneer). If battery voltage is not present, replace maxi-fuse in Power Distribution Center (PDC) located near coolant reservoir (Cherokee) or near battery (Wrangler, Grand Cherokee and Grand Wagoneer).

3) If battery voltage is present, check ignition side of fuse No. 9 (Wrangler), TURN fuse (Cherokee) or fuse No. 19 (Grand Cherokee and Grand Wagoneer) for voltage. If battery voltage is not present, check for an open circuit from ignition switch.

### DEFOGGER SWITCH TEST

Cherokee & Wrangler

1) Disconnect defogger switch connector. Turn ignition switch to RUN position. Measure voltage at defogger switch connector terminal "D". About 5 volts should be present. If about 5 volts are not present, repair open circuit from relay.

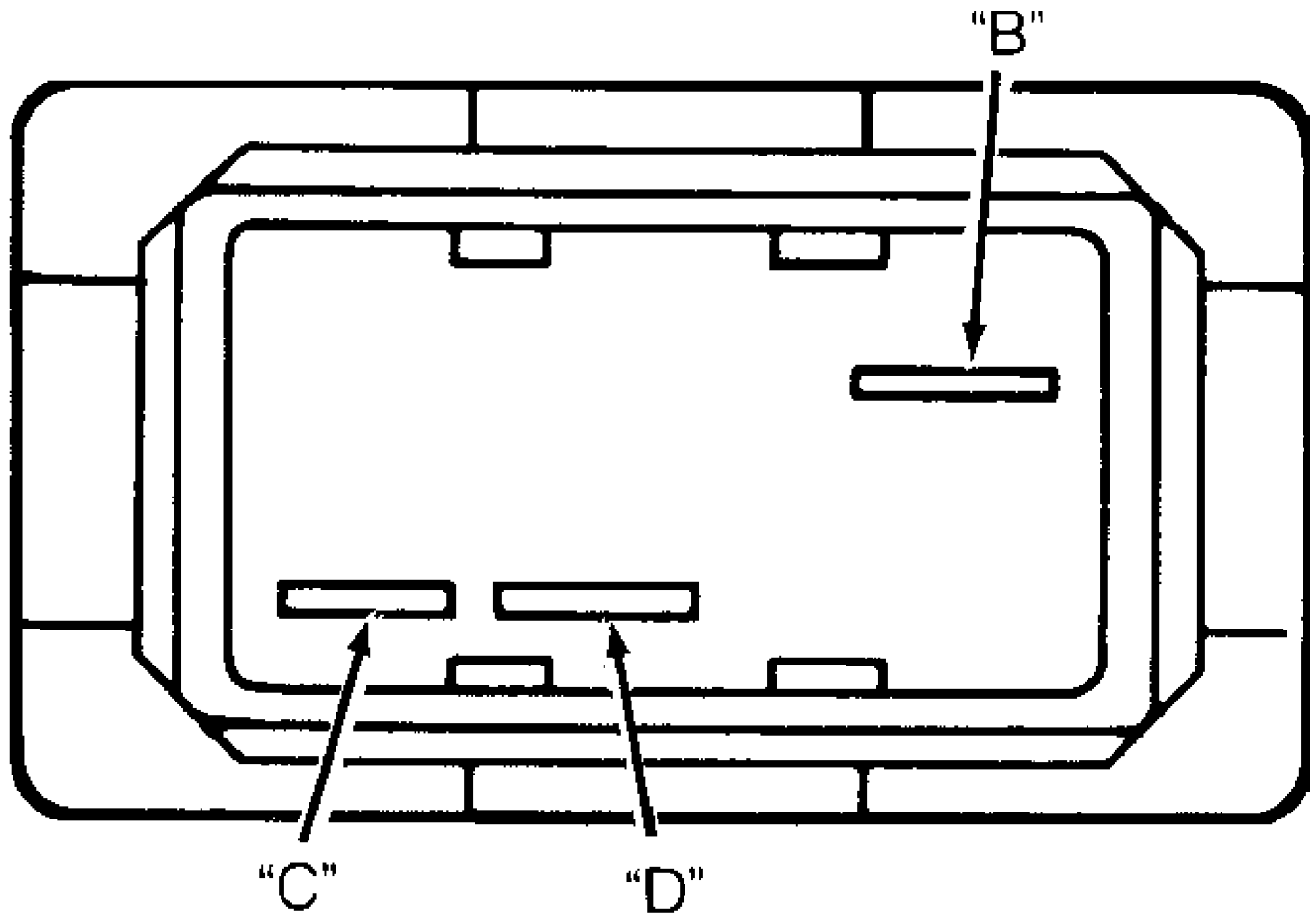
2) Measure resistance across switch terminals "B" and "D". See Figs. 1 and 2. With switch button depressed, approximately zero ohms should be present. Measure resistance across switch terminals "D" and "C". With switch button depressed, zero ohms should be present. Measure resistance across switch terminals "B" and "C". Approximately zero ohms should be present.

Grand Cherokee And Grand Wagoneer

1) Disconnect defogger switch connector. Using a jumper wire,

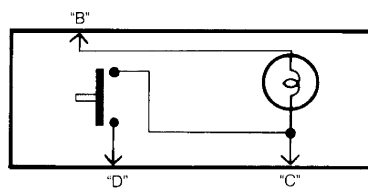
apply 12 volts to switch terminal No. 1. Using another jumper wire, connect terminal No. 3 of switch to ground. If switch indicator lights, go to next step. If indicator does not light, replace switch.

2) Remove jumper wires. Connect an ohmmeter between switch terminals No. 2 and 3. Depress switch. Ohmmeter should indicate 10 ohms. If ohmmeter does not indicate 10 ohms, replace switch. If ohmmeter indicates 10 ohms, check for an open circuit between terminal No. 1 and fuse No. 23, between terminal No. 3 and ground and between relay terminals No. 2 and 3.



**92A22327**

Fig. 1: Defogger Switch Terminal ID (Cherokee & Wrangler)  
Courtesy of Chrysler Motors.



**92B22328**

Fig. 2: Defogger Switch Internal Component ID (Cherokee & Wrangler)  
Courtesy of Chrysler Motors.

## DEFOGGER RELAY TEST

1) Disconnect defogger relay connector. Turn ignition switch to RUN position. Measure voltage at relay connector terminal No. 4 (Cherokee and Wrangler) or No. 5 (Grand Cherokee and Grand Wagoneer). Battery voltage should be present. If battery voltage is not present, repair open circuit to fuse No. 9 (Wrangler), fuse No. 19 (Grand Cherokee and Grand Wagoneer) or HTD/WDW fuse (Cherokee).

2) Measure voltage at relay connector terminal No. 4. Battery voltage should be present. If battery voltage is not present, repair open circuit from fuse No. 6 (Wrangler), TURN fuse (Cherokee) or circuit breaker No. 28 (Grand Cherokee and Grand Wagoneer).

3) Turn ignition switch to OFF position. Check resistance between relay connector terminal No. 1 and left (driver's side) of defogger grid. Zero ohms should be present. If zero ohms are not present, repair open circuit between relay connector and left side of defogger grid.

4) Measure resistance between relay connector terminal No. 2 and ground. Zero ohms should be present. If zero ohms are not present, repair open circuit between relay connector and ground.

5) Reconnect relay connector. Turn ignition switch to RUN position. Measure voltage at terminal No. 3. About 5 volts should be present. If about 5 volts are not present, replace defogger relay.

## **GRID POWER & GROUND TEST**

1) Turn defogger on. Turn ignition switch to RUN position. Measure voltage at left (driver side) of defogger grid. Battery voltage should be present. If battery voltage is not present, repair open circuit from defogger relay.

2) Turn ignition switch to OFF position. Measure resistance from right side of defogger grid to ground. Zero ohms should be present. If zero ohms are not present, repair open circuit between right side of defogger grid and ground.

## **LOCATING GRID FILAMENT BREAK**

1) With engine running, turn defogger switch on. Defogger light should illuminate. On inside glass surface, connect voltmeter positive lead to power feed side vertical grid element and the negative voltmeter lead to ground side of vertical grid element.

2) Voltmeter should read 11-13 volts. Connect voltmeter negative lead to a good ground. Voltmeter reading should remain constant. Using voltmeter positive lead, contact each grid at grid centerline.

3) Voltage reading should be approximately half the previous reading (about 6 volts). A reading of zero volts indicates a break in the grid between positive voltmeter lead (centerline) and ground. A reading of 12 volts indicates a break in the grid between power feed side and centerline (or positive voltmeter lead).

4) To pinpoint break, move voltmeter positive lead left or right along grid until a sudden change in voltmeter reading occurs. That indicates the exact location of grid filament break.

## **ON VEHICLE SERVICING**

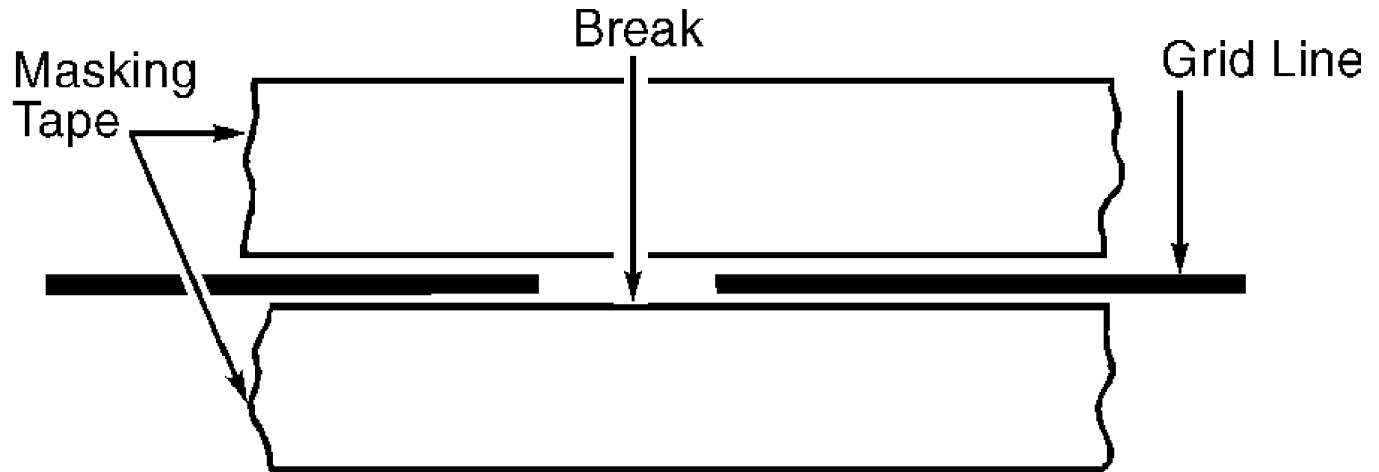
### **GRID FILAMENT REPAIR**

1) Mark location of broken or open grid on exterior surface of glass using a marking pen. Using fine steel wool, lightly rub area to be repaired inside rear window. Clean area using alcohol.

2) Place 2 strips of masking tape to inside surface of rear window, above and below break in grid. See Fig. 3. Thoroughly mix conductive epoxy. Apply epoxy on grid break, overlapping both ends of

break.

3) Carefully remove masking tape from grid line. Allow epoxy to cure 24 hours at room temperature or use a heat gun for 15 minutes. Hold gun about 10" from damaged area.



G92A01033

Fig. 3: Repairing Defogger Grid  
Courtesy of Chrysler Motors.

## REMOVAL & INSTALLATION

### DEFOGGER SWITCH

#### Removal & Installation (Cherokee)

Disconnect negative battery cable. Remove instrument panel bezel. Remove switch housing panel. Disconnect switch connector. Depress switch mounting tabs, and remove switch. To install, reverse removal procedure.

#### Removal & Installation (Grand Cherokee And Grand Wagoneer)

1) Disconnect negative battery cable. Remove ash tray. Remove 6 screws retaining center cluster bezel. Remove center bezel. Remove 2 screws holding dash pad located behind top of center bezel.

2) Pry defroster grille out of dash pad. Unplug sensors and set defroster grille aside. Remove 4 screws in defroster duct opening holding dash pad. Remove 3 screws above instrument panel cluster holding dash pad.

3) Open glove box, and remove 2 screws holding dash pad. Remove dash pad by pulling upward and unsnapping end clips. With driver's door open, remove one screw from side of lower trim panel. Remove one screw from bottom of lower trim panel and pull panel off. Ensure clip holding lower trim panel to instrument panel is disengaged.

4) Remove 4 screws holding steering column cover. Remove 3 screws holding bottom of bezels. Remove 2 screws holding top of end bezel and switch pod bezel. Remove end bezel. Remove 2 screws holding left side of switch pod bezel. Remove 3 screws holding right side of switch pod bezel.

5) Pull switch pod bezel out far enough to remove switch connectors. Disconnect connectors from each switch pod and remove bezel. Remove switch screws and switch. To install, reverse removal procedure.



Removal & Installation (Wrangler)

Disconnect negative battery cable. Remove 6 instrument panel shroud screws. Slide shroud toward steering wheel. Remove 3 defogger switch bezel screws. Disconnect defogger switch connector. Squeeze ends of switch to release plastic retaining fingers. To install, reverse removal procedure.

## **DEFOGGER RELAY**

Removal & Installation (Cherokee & Wrangler)

Rear defogger relay is Red and located behind instrument panel, to right of steering column. Remove lower instrument panel trim panel. Remove relay from connector.

Removal & Installation (Grand Cherokee And Grand Wagoneer)

Rear defogger relay is Red and located in relay center, in glove box. Remove relay center cover. Remove relay from connector.

## **WIRING DIAGRAMS**

See appropriate chassis wiring diagram in WIRING DIAGRAMS.

# DRIVE AXLE - SPICER (DANA) TRAC-LOK

1993 Jeep Cherokee

1993 Drive Axles - Differentials - Spicer (Dana) Trac-Lok

Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## DESCRIPTION

The Trac-Lok positive traction differential is a 2-pinion, single-case type. Under normal conditions, torque to each rear wheel is divided evenly. When vehicle is driven on snow, ice or mud, torque will transfer to the wheel with the greatest traction.

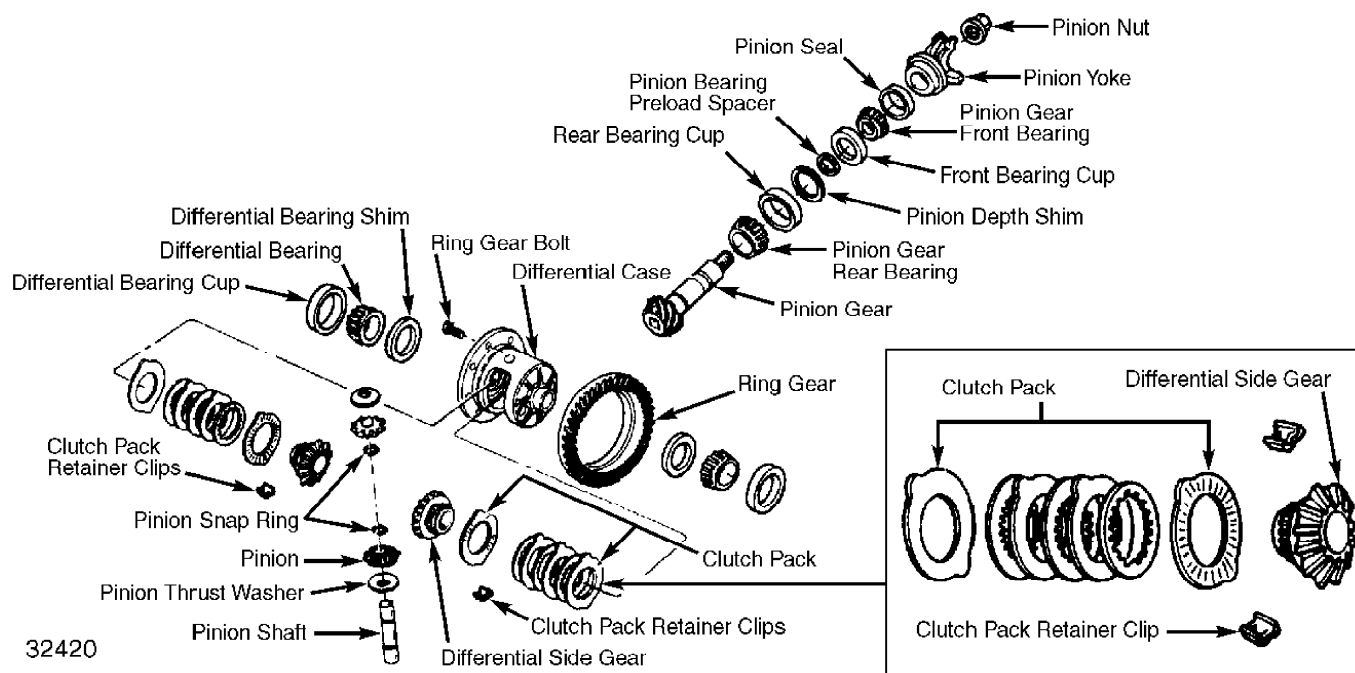


Fig. 1: Exploded View Of Trac-Lok Differential  
Courtesy of Chrysler Corp.

## LUBRICATION

NOTE: Use 75W-90 GL-5 plus Trac-Lok additive (friction modifier).

## DIAGNOSIS & TESTING

Most common Trac-Lok condition is chatter when turning corners. Incorrect or contaminated oil is usual cause.

Changing axle oil (with Trac-Lok additive) should correct the condition. After changing Trac-Lok differential oil, make 10 or 12 slow figure 8 turns. If chatter persists, clutch packs must be inspected for damage.

## REMOVAL & INSTALLATION

NOTE: This article covers overhaul of Trac-Lok (positive traction) unit. For other information, see 7 1/8", 7 9/16" & 8 1/4" RING GEARS article in this section.

## OVERHAUL

### Disassembly

1) Using 2 screwdrivers, remove pinion snap rings. Using a brass drift and a hammer, remove pinion shaft from case. See Fig. 1. Install Step Plate (C-4487-1) in side gear. Grease centering hole of step plate. Position Gear Rotator (C-4487-4) in pinion shaft hole. Coat threads of Forcing Screw (C-4487-2) with oil.

2) Insert Threaded Adapter (C-4487-3) into side gear opposite step plate. Insert Forcing Screw (C-4487-2) through threaded adapter. Thread screw through adapter until it contacts centering hole in step plate. Tighten forcing screw sufficiently to relieve clutch pack tension. Remove pinion thrust washers.

3) Loosen forcing screw until all clutch pack tension is relieved. Using gear rotator, engage side gear teeth and rotate side gears until pinions can be removed.

4) Remove step plate, threaded adapter, gear rotator, forcing screw, side gears and clutch packs. Remove clutch pack retainer clips. Mark clutch packs for reassembly reference.

### Reassembly

1) Lightly oil clutch discs. Assemble clutch pack discs. See Fig. 2. Assemble clutch packs on side gears.

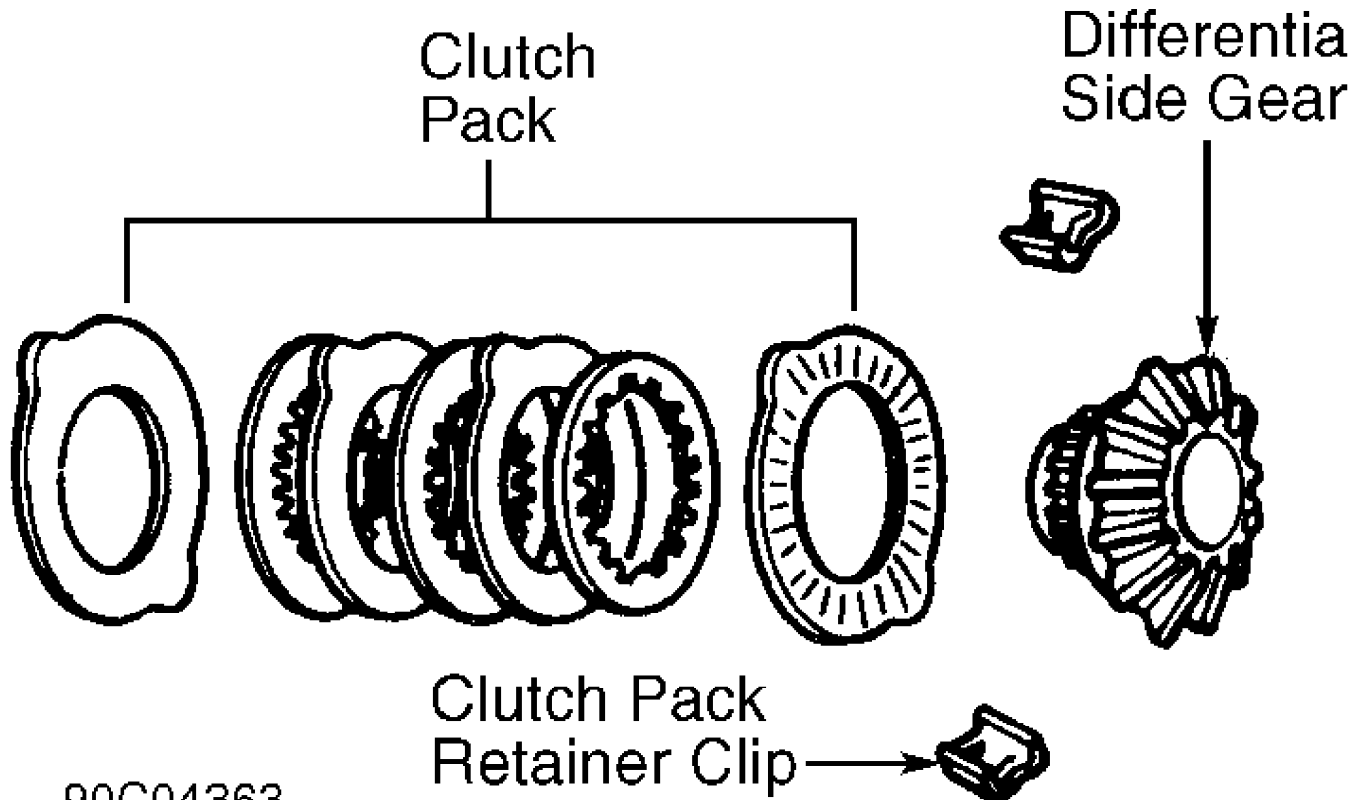


Fig. 2: Identifying Trac-Lok Clutch Pack Assembly  
Courtesy of Chrysler Corp.

2) Install clutch pack and side gear in side of case. Ensure retaining clips remain seated in case pockets. Install step plate in clutch pack just installed.

3) Install remaining side gear and clutch pack in case. Hold

assembly in position. Install rotating tool and forcing screw.

4) Tighten forcing screw and compress clutch packs. Install pinions. Rotate side gear with tool pawl until each pinion is aligned with pinion shaft bore.

5) Install pinion thrust washers. Remove tools. Install pinion shaft. Install snap rings on pinion shaft. Position ring gear on differential case. Install NEW ring gear bolts and tighten to 45-60 ft. lbs. (61-81 N.m).

# DRIVE AXLE - 7.125", 7.56" (7 9/16") & 8.25"

1993 Jeep Cherokee

1993 Drive Axles  
7 1/8", 7 9/16" & 8 1/4" Ring Gears

Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## DESCRIPTION

Front and rear drive axle assemblies have hypoid type gears with integral carrier housings. See Fig. 1. Model 30 front axle is used on all models. Model 35 rear axle is standard on all models. Cherokee models without ABS are available with optional rear axle with 8 1/4" ring gear.

Optional limited slip differentials are available. Model 35 and 44 axles use Trac-Lok limited slip system. Trac-Lok is serviceable if repair is needed. The 8 1/4" differential is available with Sure-Grip limited slip system. Sure-Grip must be replaced as an assembly if repair is necessary.

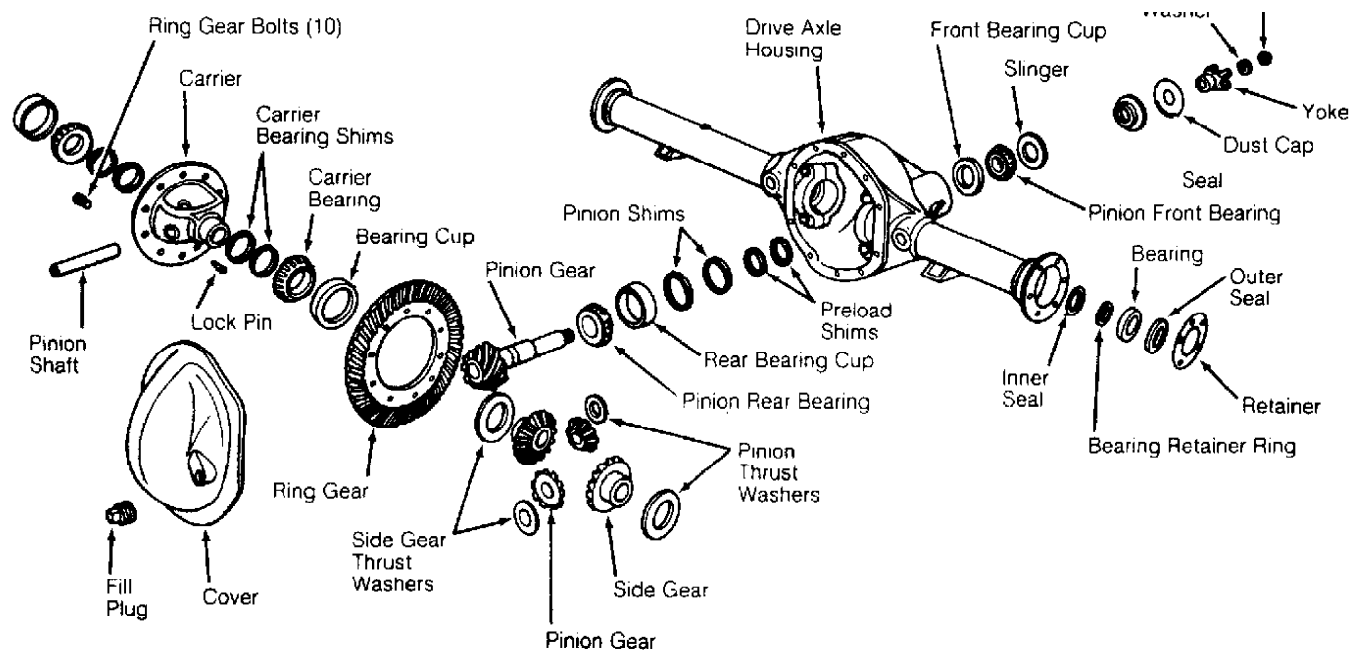


Fig. 1: Exploded View Of Rear Axle Assembly (Typical)  
Courtesy of Chrysler Corp.

## IDENTIFICATION

Axle build date and manufacturer number are stamped on passenger-side axle tube near housing cover. See Fig. 2. Axle assembly part number, gear ratio and identification tag is attached to housing cover bolts. See AXLE RATIO & IDENTIFICATION table.

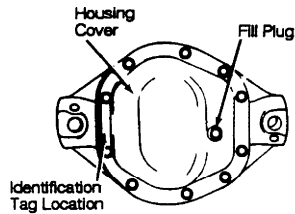
Model 35 axle shaft tubes are 2.625" (66.67 mm) in diameter.  
8 1/4" axle shaft tubes are 3.0" (76.2 mm) in diameter.

### AXLE RATIO & IDENTIFICATION TABLE

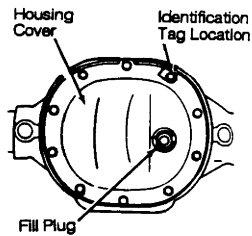
Axle Ratio	Pinion/Ring Gear Tooth Combinations	Ring Gear Diameter
------------	-------------------------------------	--------------------

Front Axle (1)				
3.07:1	.....	14/43	.....	7 1/8" (181 mm)
3.55:1	.....	11/39	.....	7 1/8" (181 mm)
4.10:1	.....	9/37	.....	7 1/8" (181 mm)
Rear Axle				
3.07:1 (2)	.....	14/43	.....	7 9/16" (192 mm)
3.55:1 (2)	.....	11/39	.....	7 9/16" (192 mm)
3.55:1 (3)	.....	11/39	.....	8 1/4" (209 mm)
4.10:1 (2)	.....	9/37	.....	7 9/16" (192 mm)
4.10:1 (3)	.....	41/10	.....	8 1/4" (209 mm)

- (1) - Model 30 axle used on all models.  
(2) - Model 35 axle used on all models.  
(3) - Optional rear axle for Cherokee only.



MODEL 30 & 35 AXLES



8 1/4" AXLE

93D75922

Fig. 2: Locating Drive Axle Identification Tag  
Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

### REAR AXLE SHAFT, BEARING, SEALS & RETAINER

**NOTE:** To service front axle shaft, bearings, seals and retainer, see FRONT AXLES article.

#### Removal

1) Raise and support vehicle. Remove rear wheel(s). Remove brake drum. Clean axle housing cover. Loosen cover bolts and drain oil. Remove cover.

2) Remove differential pinion-shaft lock screw or spring clips. Remove pinion shaft from differential. Push axle in. Remove "C" clip from axle at pinion gear. Remove axle from tube. Remove axle shaft seal and bearing from axle tube.

#### Installation

1) Grease bearing and install in axle tube. Apply wheel bearing grease to axle shaft seal. Install seal in axle tube. Install axle shaft.

2) Install axle "C" clip. Pull axle out to seat "C" clip. Install pinion shaft. Install lock screw, and tighten to

specification. Install pinion shaft spring clips (if equipped). Apply RTV to axle housing cover. Tighten cover bolts to specification. See TORQUE SPECIFICATIONS table. Fill with gear oil.

NOTE: On vehicles with Trac-Lok (limited slip) differentials, slowly drive vehicle in 10-12 "figure 8" patterns to distribute lubricant to clutch and bearing assembly.

## PINION SEAL & YOKE

### Removal

1) Raise and support vehicle. Remove wheels and brake rotor/drums. Stamp or paint a reference mark at rear drive shaft to axle yoke. Disconnect and remove drive shaft. Rotate yoke 3 or 4 times.

2) Measure amount of torque needed (in INCH lbs.) to rotate pinion gear. Record torque reading for installation procedure. Remove pinion nut and discard. DO NOT reuse nut.

3) Index mark yoke-to-pinion position for installation. Using Puller(C-452) and Yoke Support Wrench (C-3281), remove pinion yoke. Remove pinion seal, and wipe surface of seal bore clean.

### Installation

1) Coat pinion seal with axle oil and install. Align and install yoke on pinion shaft. Install NEW pinion nut and tighten only enough to remove end play. DO NOT tighten pinion nut further yet.

CAUTION: DO NOT overtighten or loosen and retighten pinion nut. If required preload torque is exceeded, replace collapsible pinion spacer and reset pinion preload.

2) Place an INCH-lb. torque wrench on pinion nut. Rotate pinion and note rotating torque. Hold yoke with Yoke Support Wrench (C-3281). Tighten pinion nut until preload torque is same as amount recorded during removal, plus 5 INCH lbs. (.56 N.m). Pinion nut torque should equal or exceed torque specification. See TORQUE SPECIFICATIONS table.

3) Align and install drive shaft. Tighten "U" joint clamp bolts. Install brake drum/rotors and wheels. Tighten lug nuts to specification. See TORQUE SPECIFICATIONS table. Check oil level.

## DRIVE AXLE HOUSING

### Removal

1) Raise and support vehicle on frame rails. Remove wheels. Index mark drive shaft and axle yoke for installation reference. Remove drive shaft.

2) Disconnect rear track bar (if equipped) at axle bracket. Remove axle vent tube at axle. Disconnect parking brake cables at equalizer (rear axle). Remove shock absorbers. Disconnect brake hose(s).

3) On all except Wrangler, support axle housing. Disconnect upper and lower control arms at axle. Lower and remove assembly to release coil spring pressure. Remove coil springs. Lower and remove axle housing assembly from vehicle.

4) On Wrangler, loosen, but DO NOT remove, bolts attaching spring eyes to frame brackets and shackles. Support axle housing. Remove spring "U" bolts and tie plates. Raise axle housing just enough to relieve weight from springs.

5) Remove bolts attaching springs to frame bracket and shackles. Lower springs to floor. Lower jack slowly, and remove axle housing assembly from vehicle.

#### Installation

Align spring mounting points, and place axle in position. To install, reverse removal procedure.

### DIFFERENTIAL CARRIER & PINION

#### Removal (Except Cherokee 8 1/4" Ring Gear)

1) Raise and support vehicle. Remove axle housing cover and drain oil. Index mark drive axle and drive shaft yokes for installation. Remove drive shaft.

2) Remove wheels, brake rotor/drums and axle shafts. Mount Housing Spreader (W-129-A) on axle housing. Mount dial indicator. Spread housing enough to remove differential carrier. See Fig. 3.

CAUTION: DO NOT spread housing more than .015" (.38 mm) or damage to housing may result.

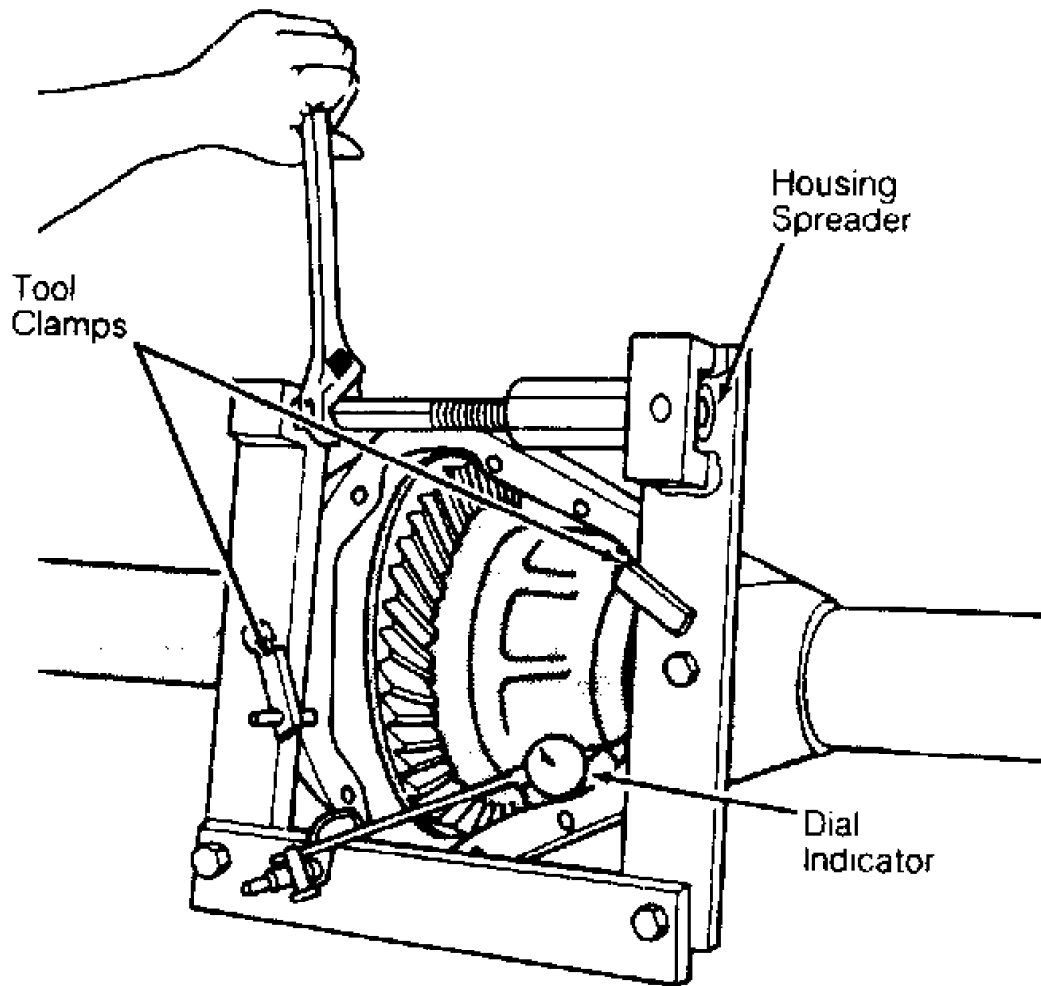


Fig. 3: Spreading Housing To Remove Differential Carrier  
Courtesy of Chrysler Corp.

3) Index mark bearing caps for installation reference. Loosen bearing caps until almost out. Pry differential carrier loose. Remove



bearing caps. Remove differential carrier. Remove housing spreader. Check the pinion preload and remove the pinion gear assembly. See PINION SEAL & YOKE.

#### Installation (Except Cherokee 8 1/4" Ring Gear)

1) Install pinion gear, pinion bearings and seal (if removed). Adjust pinion preload. See REASSEMBLY under OVERHAUL. Spread housing as during removal.

2) Place differential carrier with bearing races and shims in axle housing. Using a mallet, tap outer edges of drive axle bearing races to seat differential carrier. Remove housing spreader.

3) Install bearing caps. Tighten bolts to specification. See TORQUE SPECIFICATIONS table. Check and adjust ring gear backlash and tooth contact. If pinion gear, bearings or seal was serviced, adjust pinion preload.

4) Apply 1/4" (6.35 mm) bead of RTV sealant to axle housing cover. Install cover. Tighten cover bolts to specification. Connect drive shaft. Fill axle with 2.5 pts. (1.2L) 75W-90 gear oil.

NOTE: For differentials with Trac-Lok or Sure-Grip, add friction modifier (limited slip additive).

#### Removal (Cherokee 8 1/4" Ring Gear)

1) Raise and support vehicle. Remove wheels and brake drums. Mark drive shaft for reassembly. Remove drive shaft. Drain oil and remove housing cover. Remove pinion shaft lock screw. Remove pinion shaft.

2) Push axle shafts in and remove "C" clips. Remove axles. Measure and record differential side play, ring gear runout and pinion gear preload.

3) Mark differential gear and carrier at point of maximum runout. Side play should not exist. If ring gear runout exceeds .005" (.13 mm), replace differential carrier.

4) Remove pinion yoke and seal. Mark side bearing caps and axle housing for reassembly. Remove adjuster locks. Loosen, but DO NOT remove, bearing caps. Insert Hex Adjuster (C-4164) through axle tube and loosen hex adjuster on each side.

5) Remove bearing caps, adjusters and differential carrier. Keep all bearing races, bearings and adjusters together. Using brass drift, hammer pinion shaft out of housing.

6) Drive bearing races out of housing. Remove shim(s) from behind rear races, and record thickness. Remove bearing from pinion shaft using Bearing Puller (C-293-PA) and Bearing Remover Adapter (C-293-42).

7) Mount differential carrier in soft-jawed vise. Remove and discard ring gear bolts (LEFT-HAND thread). Using soft-faced hammer, drive ring gear off differential carrier.

#### Installation (Cherokee 8 1/4" Ring Gear)

1) Install pinion gear, pinion bearings, and seal (if removed). Adjust pinion preload. See REASSEMBLY under OVERHAUL. Place differential carrier with adjusters in axle housing.

2) Install bearing caps. Check and adjust ring gear backlash and tooth contact. Preload differential carrier bearings. Tighten bolts to specification. Tighten adjuster lock screws to specification.

3) Apply 1/4" (6.35 mm) bead RTV sealant to axle housing cover. Install cover. Tighten cover bolts to specification. Connect drive shaft. Using 75W-90 gear oil, fill axle with 4.4 pts. (2.0L) of fluid.

## OVERHAUL

NOTE: Manufacturer does not recommend overhaul of optional Sure-Grip limited slip differential used on Cherokee with 8 1/4" ring gear. It must be replaced as an assembly.

## DISASSEMBLY

NOTE: On models equipped with Trac-Lok, see DIFFERENTIALS - SPICER (DANA) TRAC-LOK article for overhaul of limited slip unit. Following overhaul procedures apply to drive axle gears. Removing complete drive axle housing is not necessary to overhaul assembly.

1) Place drive axle assembly on bench. Using 2 feeler gauges, measure carrier side gear clearance. See Fig. 4. If side gear clearance exceeds specification, replace both side gear thrust washers. See SIDE GEAR CLEARANCE SPECIFICATIONS table.

SIDE GEAR CLEARANCE SPECIFICATIONS TABLE

Application	Maximum Clearance	In. (mm)
Model 30 & 35 .....	.006	(.15)
8 1/4" Ring Gear .....		N/A

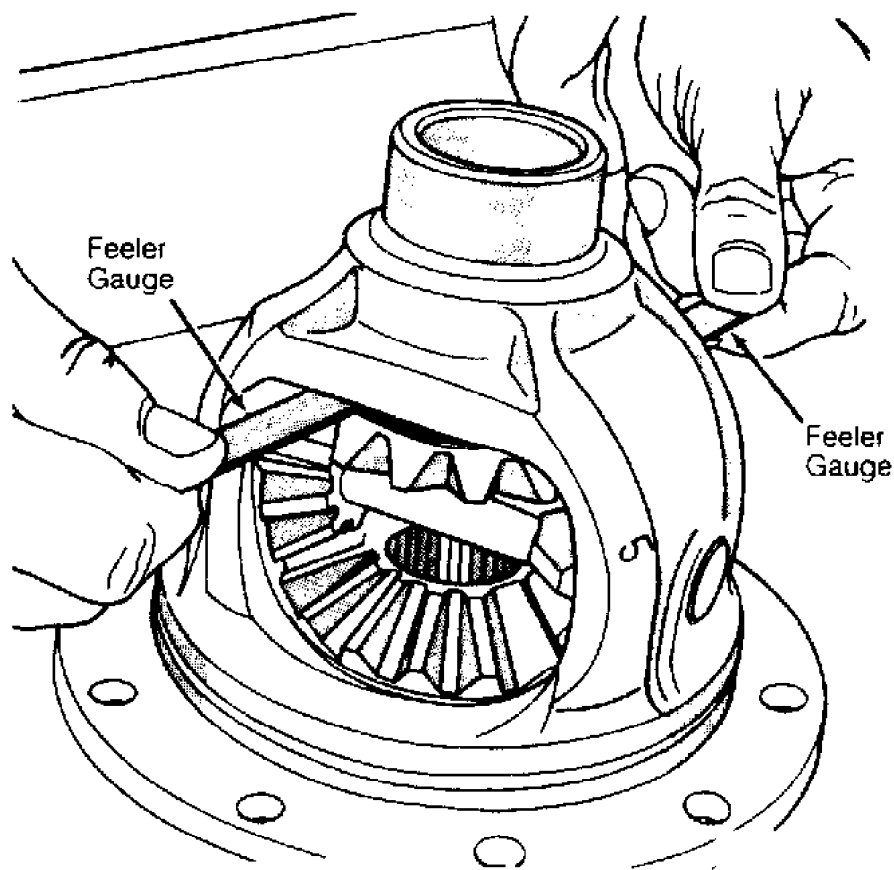


Fig. 4: Checking Side Gear Clearance  
Courtesy of Chrysler Corp.

2) Remove and discard ring gear bolts (left-hand thread on Cherokee 8 1/4" rear axle). Remove ring gear. Remove pinion gears and

thrust washers. Remove side gears and thrust washers.

3) Remove yoke nut, washer and pinion yoke. Keep pinion nut for pinion depth adjustment during reassembly. Remove pinion gear, pinion bearings and preload shims. Discard collapsible spacer.

4) Remove pinion seal and rear pinion bearing race. Remove and retain pinion depth shim located under rear bearing race. Remove pinion front bearing race. Press off pinion gear rear bearing from pinion gear See Fig. 5. On front axles, remove inner axle housing seals.

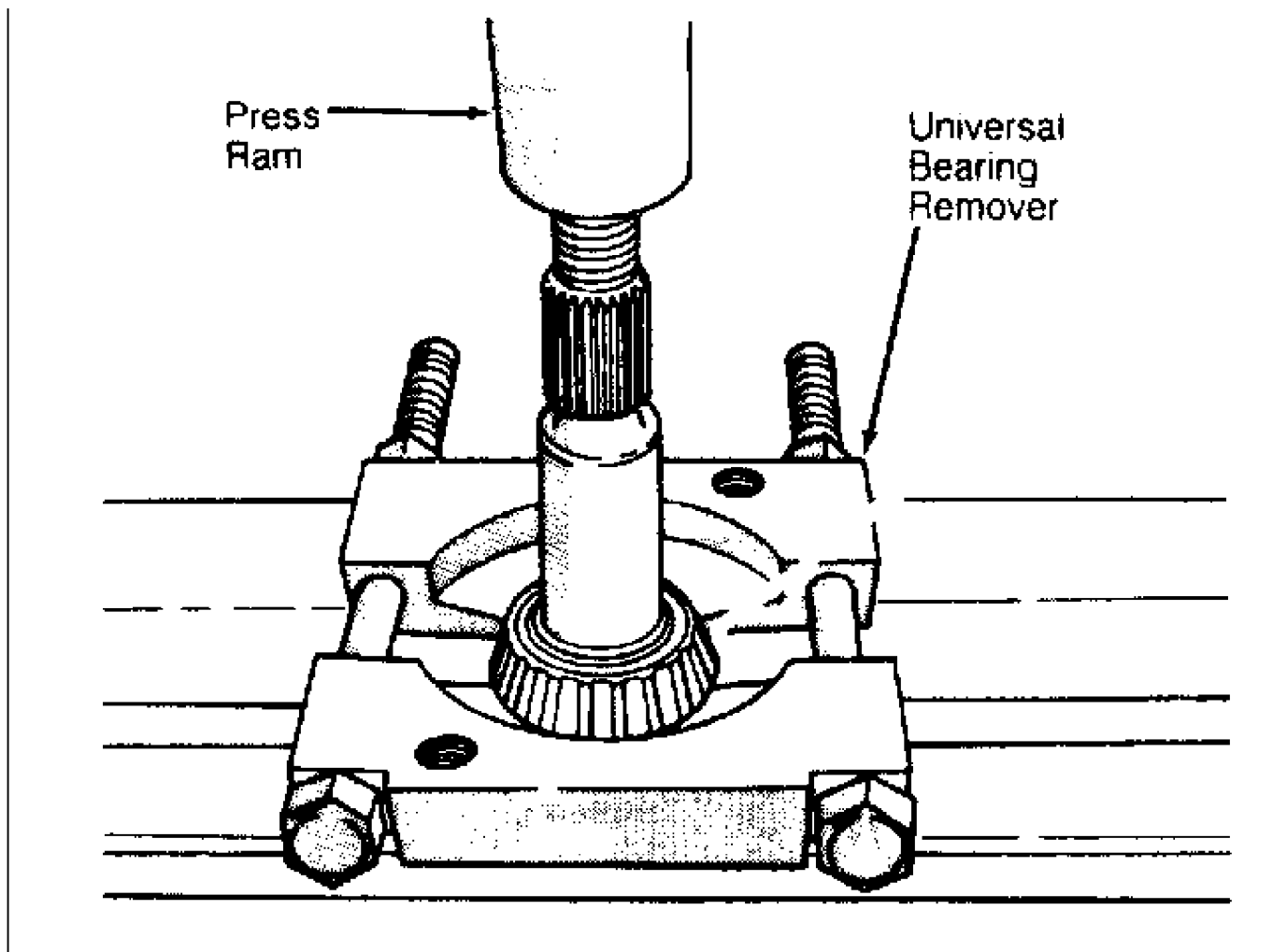


Fig. 5: Pressing Off Pinion Gear Rear Bearing  
Courtesy of Chrysler Corp.

## CLEANING & INSPECTION

Clean and inspect all parts. Replace any worn, cracked, chipped or broken parts. Replace ring and pinion gears as a complete set if either gear is worn or damaged. If necessary, axle and differential pinion gears must be replaced as a complete set. Inspect carrier case for wear and cracks, and replace it if necessary.

## REASSEMBLY

NOTE: Ensure correct shims are chosen to obtain proper ring gear backlash and bearing preload before reassembly. See

## ADJUSTMENTS.

### Pinion Gear

1) Install oil slinger (front axle). Press rear bearing on pinion gear shaft. Place original shim (or see ADJUSTMENTS) in rear bearing bore, and install rear bearing race.

NOTE: Install shim so chamfered side is toward bottom of rear bearing bore.

2) On all axles, install front bearing race into housing. Install pinion gear. Install front bearing over pinion gear. Apply oil to seal. Install seal, yoke, washer and original pinion nut. Tighten nut to remove bearing end play only.

3) Remove original pinion nut, washer, yoke and front bearing. Install NEW collapsible spacer on pinion. Reinstall components and front oil slinger (if equipped) in order using NEW pinion nut.

4) Preload pinion bearing. See PINION SEAL & YOKE under REMOVAL & INSTALLATION. Using an INCH-lb. torque wrench, check pinion bearing preload by measuring torque needed to rotate pinion gear. See PINION BEARING PRELOAD SPECIFICATIONS table. If preload is not within specification, see PINION BEARING PRELOAD under ADJUSTMENTS.

### PINION BEARING PRELOAD SPECIFICATIONS TABLE

Applications	INCH Lbs. (N.m)
Models 30 & 35 Axle	
New Bearing .....	20-40 (2-5)
Original Bearing .....	10-20 (1-2)
8 1/4" Ring Gear .....	10-20 (1-2)

### Differential Carrier

1) Assemble side gears with thrust washers, and install into carrier. Replace side gear thrust washers if one or both side clearance checked during disassembly was greater than specification. See SIDE GEAR CLEARANCE SPECIFICATIONS table under DISASSEMBLY.

2) Install carrier pinion gears and thrust washers into carrier. Using Bearing Puller (J-22888) and Thrust Pad (J-22888-9), remove carrier bearings. See Fig. 6. Note if shims are used between carrier bearing and carrier.

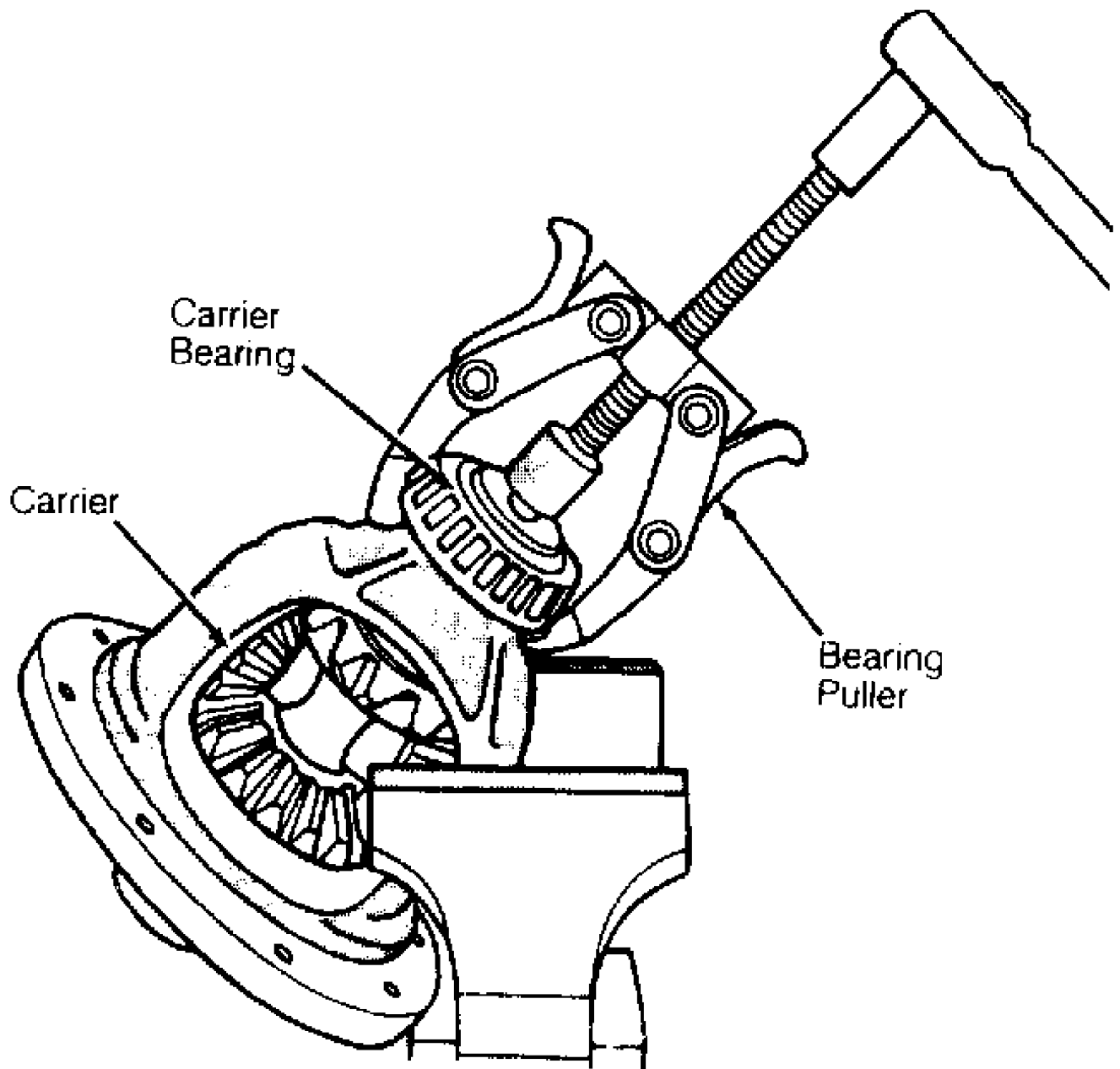


Fig. 6: Removing Drive Axle Carrier Bearings  
Courtesy of Chrysler Corp.

3) Install shims (if equipped), and press carrier bearings onto carrier. Using heat lamp, heat ring gear to 250°F (121°C). Install ring gear on carrier. Install NEW ring gear bolts (LEFT-HAND thread on Cherokee with 8 1/4" rear axle).

4) Tighten ring gear bolts to specification. To complete reassembly, see DIFFERENTIAL CARRIER & PINION under REMOVAL & INSTALLATION. Check ring gear backlash. See RING GEAR BACKLASH under ADJUSTMENTS.

## ADJUSTMENTS

NOTE: Ring and pinion gears are serviced as matched set only. They are identified by numbers etched on gear and pinion. See Fig. 7. First number (2 or 3 digits) identifies matched set. Second number on pinion gear (preceded by a "+" sign) is pinion depth variance. This number indicates amount (in thousandths of an inch) gear set varied from standard setting. See PINION GEAR STANDARD DEPTH SPECIFICATIONS table.

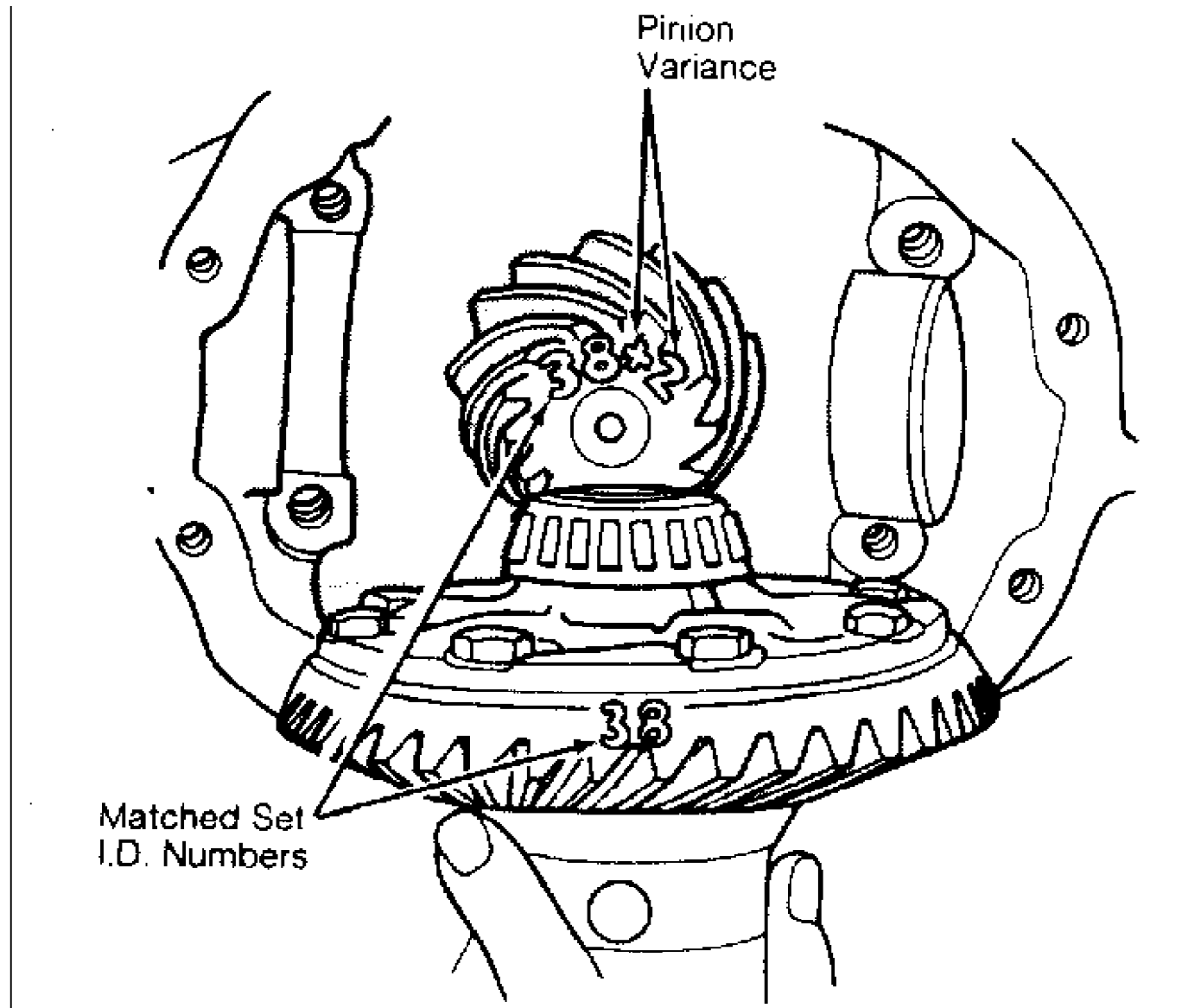


Fig. 7: Matching Ring & Pinion Gear Set  
Courtesy of Chrysler Corp.

### PINION GEAR STANDARD DEPTH SPECIFICATIONS TABLE

Application	Standard Depth: In. (mm)
Front Axle (Models 30) .....	2.250 (57.15)

#### Rear Axle

Model 35 ..... 2.095 (53.29)  
8 1/4" Ring Gear ..... N/A

### DETERMINING CORRECT PINION STARTING SHIM

1) If original ring and pinion are being installed, use original shim. If new parts (gear set) are being installed, use following steps to determine best starting shim thickness.

2) Check numbers etched on drive pinion and ring gear. Measure thickness of original pinion shim. Note variance number on pinion gear. See Fig. 7. Note where old and new pinion marking columns intersect on chart. See Fig. 8.

3) Intersecting figure represents amount needed to add or subtract from original shim. For example, if old pinion is +1 and new pinion is -3, intersecting figure is +.004" (+.10 mm). Add this amount to original shim. If old pinion is -3 and new pinion is -2, intersecting figure is -.001" (-.025 mm). See Fig. 8. Subtract this amount from original shim.

OLD PINION MARKING	NEW PINION MARKING								
	-4	-3	-2	-1	+0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

93H44930

Fig. 8: Pinion Variance Chart  
Courtesy of Chrysler Corp.

### PINION BEARING PRELOAD

1) Apply oil to seal. Install seal, yoke, washer and original nut. Tighten pinion nut only enough to remove bearing end play. Remove original nut, washer and yoke and install NEW collapsible spacer. Reassemble components, including oil slinger (if equipped).

CAUTION: Never reuse collapsible spacer.

2) Place an INCH-lb. torque wrench on pinion nut. Rotate pinion and note rotating torque. Hold yoke using Yoke Support Wrench (J-8614-1). Tighten pinion nut until preload torque is 15-25 INCH lbs. (2-3 N.m). Pinion nut torque should equal or exceed specification. See TORQUE SPECIFICATIONS table. If pinion nut torque does not equal or exceed specification, replace collapsible spacer.

CAUTION: DO NOT overtighten pinion nut. If preload torque is exceeded, collapsible spacer must be replaced and preload reset.

### CARRIER BEARING END PLAY

NOTE: This adjustment is not required on Cherokee 8 1/4" rear axle.

1) Place bearing race over each carrier bearing. Install carrier assembly (without ring gear) into axle housing. Install a .142" (3.60 mm) shim on outer side of each carrier bearing race.

2) Install bearing caps. Tighten bolts finger tight. Mount dial indicator to housing. See Fig. 9. Using a pry bar between shims and housing, move assembly to one side. Zero dial indicator. Pry assembly to opposite side. Record indicator reading. DO NOT zero or read indicator while prying.

3) Indicator reading (when divided by 2; one for each side) is thickness of shims required. Shims are available in .002" (.050 mm) increments.

4) When all side play is eliminated, check drive gear face of carrier for runout by rotating carrier and reading dial indicator. Runout should not exceed .002" (.050 mm). Remove carrier from housing, and retain shims. See Fig. 9.

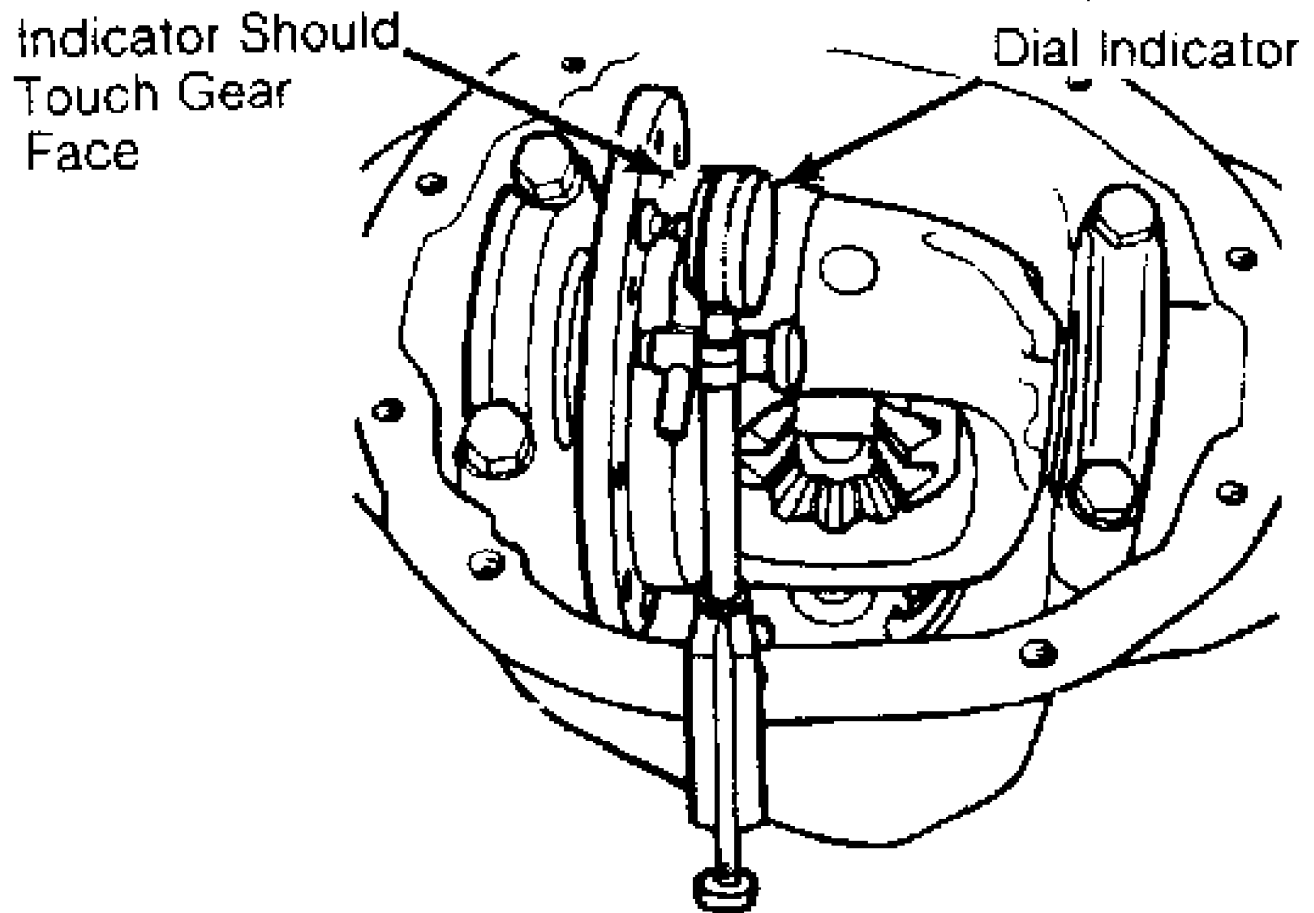


Fig. 9: Checking Carrier Bearing End Play & Runout  
Courtesy of Chrysler Corp.

### RING GEAR BACKLASH

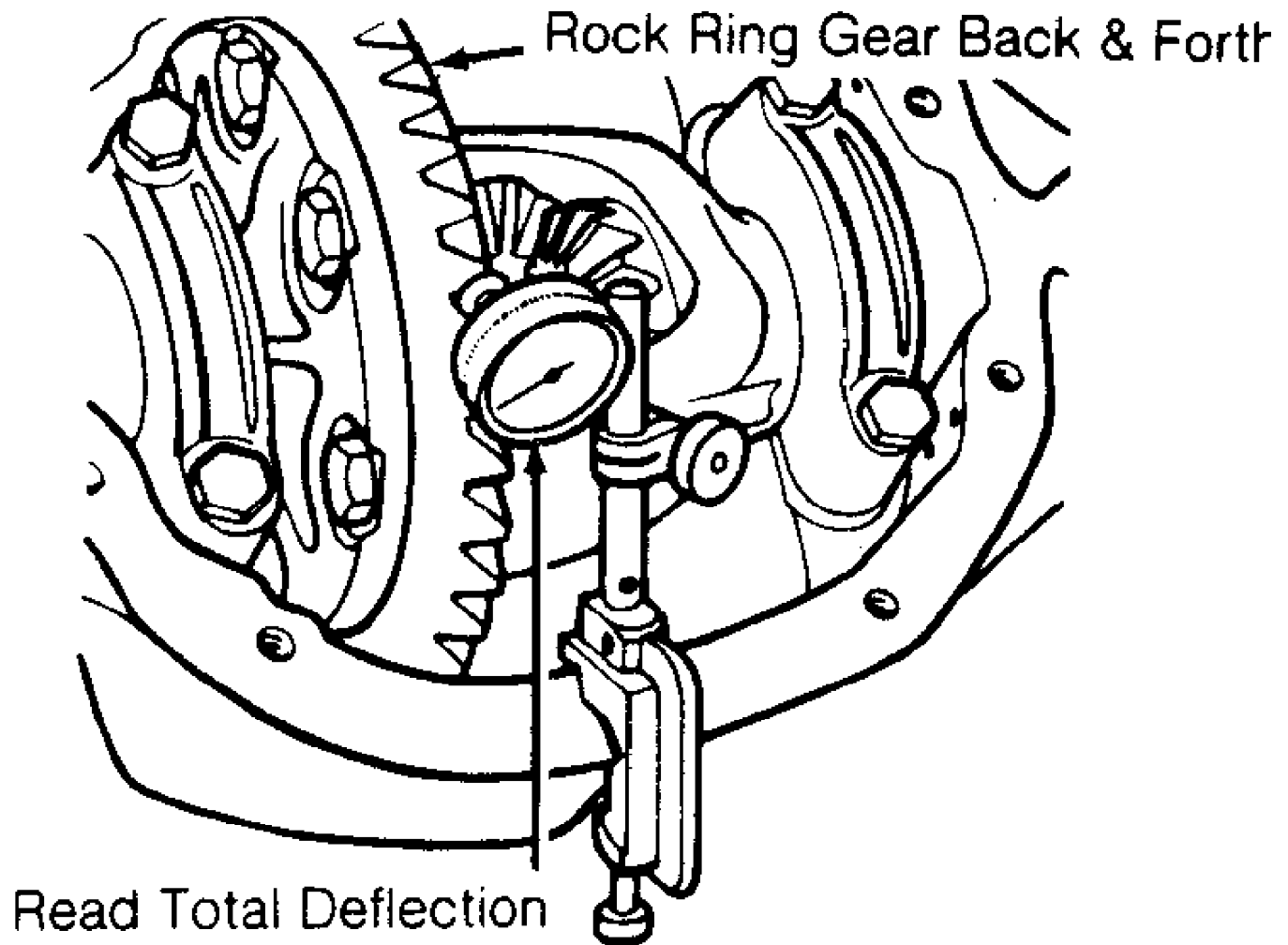
Except Cherokee 8 1/4" Ring Gear

1) Install carrier assembly into housing using shims selected to remove end play. Tighten bearing cap bolts evenly to specification.

2) Attach a dial indicator to housing so button of indicator contacts drive side of ring gear tooth. Rock ring gear, and note



backlash. See Fig. 10.



29232

Fig. 10: Checking Ring Gear Backlash  
Courtesy of Chrysler Corp.

3) Backlash should be .005-.009" (.13-.23 mm). To increase backlash, install thinner shim on ring gear side of case and a thicker shim on opposite side of case. To decrease backlash, reverse this step. DO NOT change total shim thickness.

4) After all adjustments, check gear tooth pattern, and adjust if necessary. See GEAR TOOTH CONTACT PATTERNS article in GENERAL INFORMATION.

#### Cherokee 8 1/4" Ring Gear

1) Using hex adjuster, turn each adjuster until bearing free play is eliminated with about .010" (.25 mm) backlash. To ensure accurate adjustment, seat bearings by rotating differential carrier 1/2 turn, back and forth, 5-10 times each time adjusters are moved.

NOTE: Index gears so same teeth are meshed during all backlash measurements. Maintain specified adjuster torque to obtain accurate differential bearing preload.

2) Mount dial indicator on flange. Position indicator stem against drive side of ring gear. Check backlash every 90 degrees to find point of minimum backlash. Mark each position so backlash readings will be taken with same teeth meshed. Rotate ring gear to point of minimum backlash.

3) Tighten each adjuster to 10 ft. lbs. (14 N.m). Seat bearings as in step 1). Measure backlash. If necessary, back out right or left adjuster and turn in right or left adjuster until backlash is .003-.004" (.08-.10 mm). Tighten and seat carrier bearings each time adjusters are moved.

4) Tighten bearing cap bolts to 100 ft. lbs. (136 N.m). Using hex adjuster, tighten right adjuster to 70 ft. lbs. (95 N.m). Seat bearings, and continue to tighten adjuster until torque remains constant at 70 ft. lbs. (95 N.m).

5) Check backlash again with indicator. If backlash is not between .005-.008" (.13-.20 mm), increase torque on right adjuster and seat bearings. Continue until backlash is .005-.008" (.13-.20 mm). Tighten left adjuster to 70 ft. lbs. (95 N.m), and seat bearings. With adjustments completed, install adjuster locks. Make sure lock teeth are engaged in adjuster threads. Tighten lock bolts to specification.

6) After all adjustments, check gear tooth pattern and adjust if necessary. See GEAR TOOTH CONTACT PATTERNS article in GENERAL INFORMATION.

## CARRIER BEARING PRELOAD

NOTE: Pre-loading carrier bearings may change backlash setting. Recheck backlash, and adjust it as necessary.

CAUTION: DO NOT spread housing more than .02" (.5 mm), or damage to housing may result.

Except Cherokee 8 1/4" Ring Gear

1) Preload carrier bearings by adding .004" (.10 mm) to each existing shim. Mount Housing Spreader (W-129-A) on axle housing. Mount dial indicator. Spread housing enough to remove differential. See Fig. 3.

2) Position carrier assembly into axle housing bearing bores. Tap bearing races until fully seated in housing. Remove housing spreader. Install bearing caps, aligning marks made at disassembly. Install and tighten bolts. Recheck ring gear backlash.

Cherokee 8 1/4" Ring Gear

Carrier bearings are preloaded during backlash adjustment.

See RING GEAR BACKLASH.

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Axle Housing Cover .....	20 (27)
Differential Carrier Bearing Caps	
Except 8 1/4" Ring Gear .....	57 (77)
8 1/4" Ring Gear .....	100 (136)
Drive Shaft "U" Joint Clamp Bolts .....	14 (19)
Leaf Spring Front Eye Bolts .....	105 (142)
Leaf Spring Shackle Bolts .....	95 (129)
Leaf Spring "U" Bolt Nuts .....	90 (122)
Pinion Yoke Nut	
Except 8 1/4" Ring Gear .....	200 (271)

8 1/4" Ring Gear .....	210 (285)
Ring Gear Bolts	
Except 8 1/4" Ring Gear .....	45-60 (61-81)
8 1/4" Ring Gear .....	70 (95)
Wheel Lug Nuts .....	75 (102)

INCH Lbs. (N.m)

Adjuster Lock Screws (Cherokee, 8 1/4" Ring Gear) .....	90 (10)
Pinion Shaft Lock Bolt .....	102 (11)

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# DRIVE AXLE - FRONT

## 1993 Jeep Cherokee

1993 Drive Axles - Front Axles

Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION

Model 30 axle is used on all 4WD applications. Cherokee uses Selec-Trac 4WD system. Wrangler uses Command-Trac 4WD system. Grand Cherokee and Grand Wagoneer use a full-time 4WD system.

Command-Trac is a part-time system designed for off-road use. Command-Trac uses a vacuum operated axle disconnect mechanism to control 4WD operation.

Selec-Trac is a combination part-time/full-time system designed for both highway and off-road use. Transfer case shifter is used to control 4WD operation.

### AXLE RATIO & IDENTIFICATION

Axle build date and manufacturer's number are stamped on passenger-side axle tube, near housing cover. Axle assembly part number, gear ratio and identification tag are attached to the left side of the housing cover. See AXLE RATIO & IDENTIFICATION table.

AXLE RATIO & IDENTIFICATION TABLE

Axle Ratio	Pinion/Ring Gear Tooth Combinations		Ring Gear Diameter
Front Axle (1)			
3.07:1	14/43	7 1/8"	(181 mm)
3.55:1	11/39	7 1/8"	(181 mm)
4.10:1	9/37	7 1/8"	(181 mm)

(1) - Model 30 axle used on all models.

### REMOVAL & INSTALLATION

NOTE: This article covers removal, installation and overhaul of front axle components. For information on differential, see 7 1/8", 7 9/16" & 8 1/4" RING GEARS article.

### AXLE ASSEMBLY

Removal (Except Wrangler)

1) Raise and support vehicle under frame. Remove wheels. Remove disc brake calipers. Hang calipers aside with wire. Remove rotors and brake shields.

2) Disconnect breather tube at axle. Remove vent hose from differential housing. Remove stabilizer bar link, tie rod and drag link. Remove front drive shaft. Disconnect shock absorbers and steering damper. If equipped with Anti-Lock Brake System (ABS), disconnect brake sensor.

3) Disconnect track bar. Position jack under axle. Disconnect upper and lower control arms at axle. Lower and remove axle slowly to release coil spring pressure.

Installation (Except Wrangler)

Raise axle into position while guiding coil springs into position. Connect upper and lower control arms to axle. To complete installation, reverse removal procedure.

#### Removal (Wrangler)

1) Raise vehicle. Position supports under frame rails at rear of front springs. Remove wheels. Remove brake calipers and hang aside with wire. Remove brake rotors. Disconnect Command-Trac vacuum harness.

2) Mark front drive shaft and axle yoke for reassembly. Disconnect front drive shaft at axle yoke. Secure shaft to frame with wire. Disconnect tie rods at steering knuckles. Remove steering damper. Remove shock absorbers. Remove retaining nuts and bolts from track bars at axle shaft tube brackets. Disconnect breather tube at axle. Disconnect stabilizer bar link bolts at spring brackets.

3) Support axle and raise jack slightly to relieve spring tension. Remove spring "U" bolts and brackets. Loosen nuts attaching spring rear shackles to springs. Remove bolts attaching spring front shackles. Lower springs to floor. Remove axle assembly.

#### Installation (Wrangler)

To install, reverse removal procedure.

### AXLE SHAFT

#### Removal

1) Raise and support vehicle. Remove wheels, caliper and rotor. Remove cotter pin, lock nut and axle hub nut.

2) Remove hub-to-steering knuckle bolts. Remove hub and rotor shield from steering knuckle. Remove left axle shaft from axle tube. On models with Command-Trac, disconnect vacuum harness. Remove vacuum motor housing. See Fig. 1.

3) Remove right axle shaft from axle tube. Ensure shift collar remains on intermediate shaft.

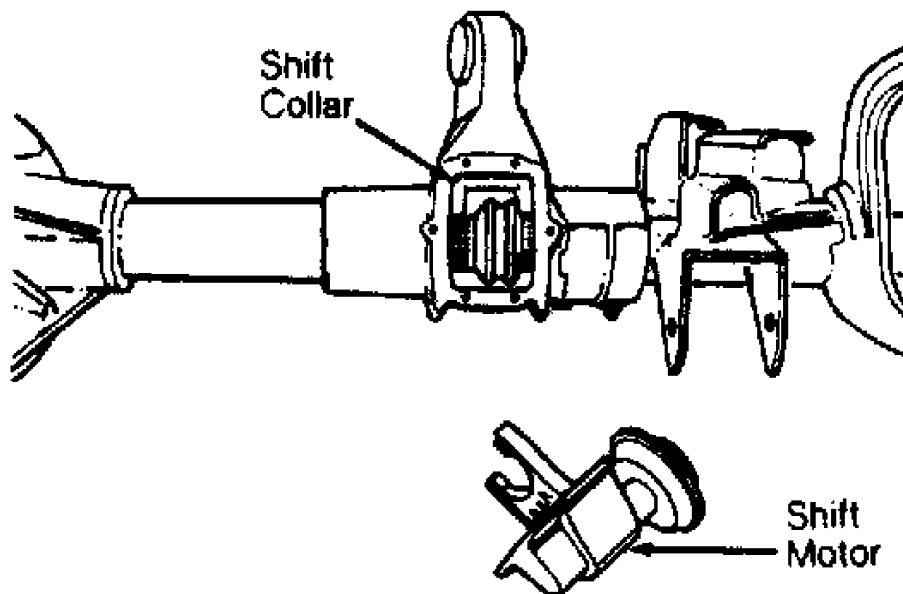


Fig. 1: Removing Command-Trac Shift Motor  
Courtesy of Chrysler Corp.

#### Installation

1) Install right and left axle shafts in axle tubes. On

models with Command-Trac, ensure shift collar is correctly positioned on intermediate axle shaft.

2) Ensure outer axle shaft is completely engaged with shift collar and joined with intermediate axle shaft. See Fig. 1. Install shift motor. Ensure fork engages with shaft collar.

3) On all models, lubricate hub bore in steering knuckle with wheel bearing grease. Install rotor shield. Install hub on axle. Slide hub into steering knuckle hub bore. Tighten hub bolts. Install the washer and the hub nut. Tighten hub nut to proper specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Install retainer and cotter pin. Install rotor, caliper and wheel. Lower vehicle.

## INTERMEDIATE AXLE SHAFT

### Removal & Installation (Wrangler)

Remove outer axle. Remove differential cover and drain fluid. Remove intermediate shaft retaining clip. See Fig. 2. Remove intermediate shaft. To install, reverse removal procedure. Fill differential housing with 2.5 pts. (1.2L) of SAE 75W-90 gear oil.

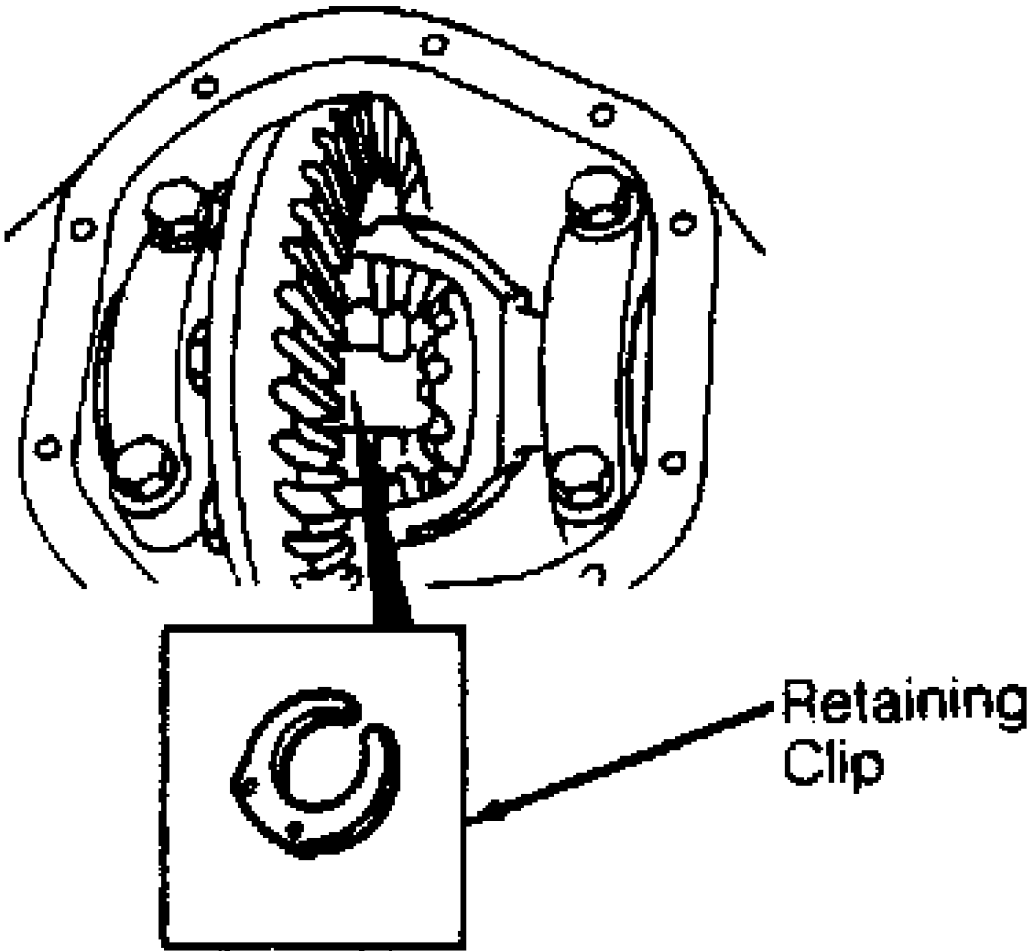


Fig. 2: Removing Intermediate Shaft Retaining Clip  
Courtesy of Chrysler Corp.

## HUB & BEARING

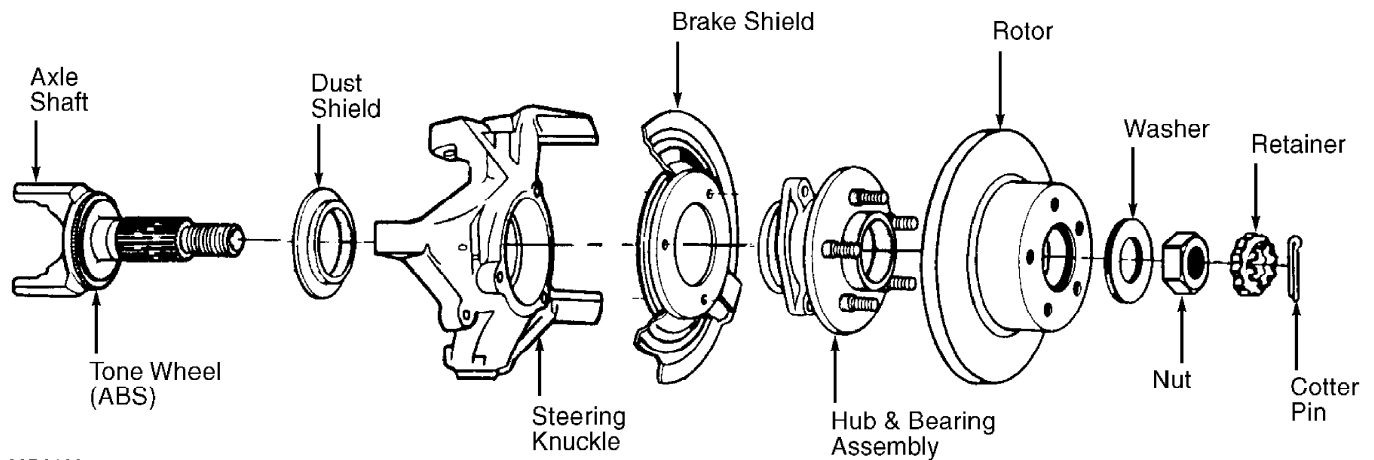
#### Removal

Raise and support vehicle. Remove wheel, caliper and rotor. Remove cotter pin, nut retainer, hub nut and washer. Remove hub-to-knuckle bolts. Remove hub from steering knuckle. See Fig. 3.

#### Installation

Apply wheel bearing grease to hub bore in steering knuckle and install hub and bearings. To complete installation, reverse removal procedure.

**NOTE:** Hub bearings cannot be serviced. If defective, replace complete hub assembly.



92D21835  
Fig. 3: Exploded View Of Hub Assembly  
Courtesy of Chrysler Corp.

## OVERHAUL

### AXLE SHAFT OUTER "U" JOINT

Remove axle shaft. Remove bearing cap and snap rings. Press out bearings caps from yoke. To install, reverse removal procedure. Pack replacement bearing caps 1/3 full of bearing grease.

### AXLE SHAFT CV JOINT

**NOTE:** If worn or damaged, CV joint MUST be replaced as a complete assembly.

#### Disassembly

1) Remove boot clamps. Carefully slide boot down axle shaft. Remove lubricant to expose CV joint components. Place joint in soft-jawed vise. Remove internal circlip and slide CV joint from shaft. Using paint, mark hub, bearing cage and housing for reassembly reference.

2) Press down on one side of bearing cage to access bearing balls. If CV joint is tight, use a hammer and brass drift to loosen hub. DO NOT strike cage or ball. Remove balls. Remove hub and cage from housing. Align hub lands with cage windows. Rotate hub 90 degrees and remove hub from cage. Inspect components for wear and damage. Replace joint, if necessary.

#### Reassembly

1) Lightly oil components before reassembly. Align reference marks. Install hub into cage. Install hub/cage into housing. Tilt cage

and insert balls into hub raceways. Push high side of hub/cage assembly into housing. Ensure assembly rotates freely in housing. Install shaft and circlip.

2) Pack bearing assembly with molybdenum base CV joint grease. Slide boot over CV joint. Install NEW boot clamps. Check shaft and joint for smooth movement.

## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Applications	Ft. Lbs. (N.m)
Cherokee	
Axle Yoke Nut .....	210 (285)
Hub Bolt .....	75 (102)
Hub Nut .....	175 (237)
Lower Control Arm Bolt .....	85 (115)
Track Bar Axle Bracket Nut .....	74 (100)
Track Bar Frame Nut .....	31 (42)
"U" Joint Strap Bolt .....	14 (19)
Upper Control Arm Bolt .....	55 (75)
Grand Cherokee & Grand Wagoneer	
Hub Bolt .....	75 (102)
Hub Nut .....	175 (237)
Spring Pivot Bolt .....	100 (136)
Track Bar Axle Bracket Nut .....	74 (100)
Track Bar Ball Stud Nut .....	60 (81)
Upper Control Arm Bolt .....	55 (75)
Wrangler	
Axle Yoke Nut .....	210 (285)
Frame Bracket .....	105 (142)
Hub Bolt .....	75 (102)
Hub Nut .....	175 (237)
Shackle Bolt .....	95 (129)
Track Bar Axle Nut .....	74 (100)
Track Bar Frame Nut/Bolt .....	125 (169)
"U" Bolt At Axle Tube Retaining Nut .....	90 (122)
"U" Joint Strap Bolt .....	14 (19)
	INCH Lbs. (N.m)
Vacuum Shift Motor Bolt .....	98 (11)



# DRIVE BELT ROUTING

## 1993 Jeep Cherokee

1993 ENGINE COOLING  
Chrysler Corp. Drive Belt Routing

Jeep; Cherokee, Grand Cherokee, Wrangler

NOTE: Information for Grand Cherokee and Grand Wagoneer with 5.2L V8 engine is not available from manufacturer.

### SPECIFICATIONS

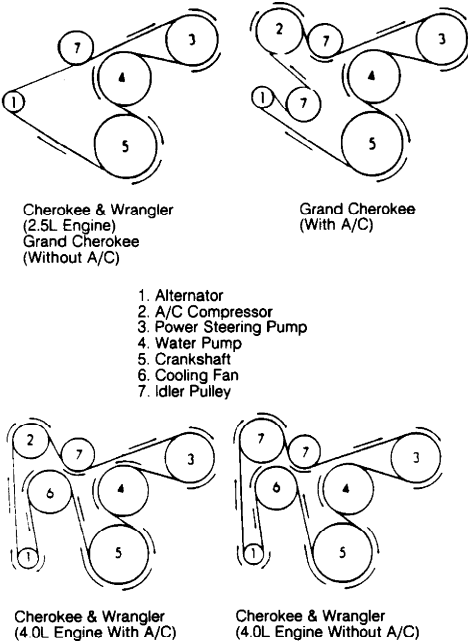
#### BELT ADJUSTMENT

Loosen rear mounting bolts of idler pulley or power steering pump (if equipped). Loosen power steering pivot bolt and lock nut (if equipped). Turn adjusting bolt to tighten belt to specification. See BELT TENSION table. Tighten bolts and lock nut to 20 ft. lbs. (27 N. m). For serpentine belt routing, see Fig. 1.

BELT TENSION TABLE (1)

Application	New Belt	Used Belt
Serpentine Belt .....	180-200 (82-91) .....	140-160 (64-73)

(1) - Tension in lbs. (kg) using strand tension gauge.



93A75911  
Fig. 1: Routing Serpentine Belts  
Courtesy of Chrysler Corp.

# DRIVE SHAFT & UNIVERSAL JOINTS

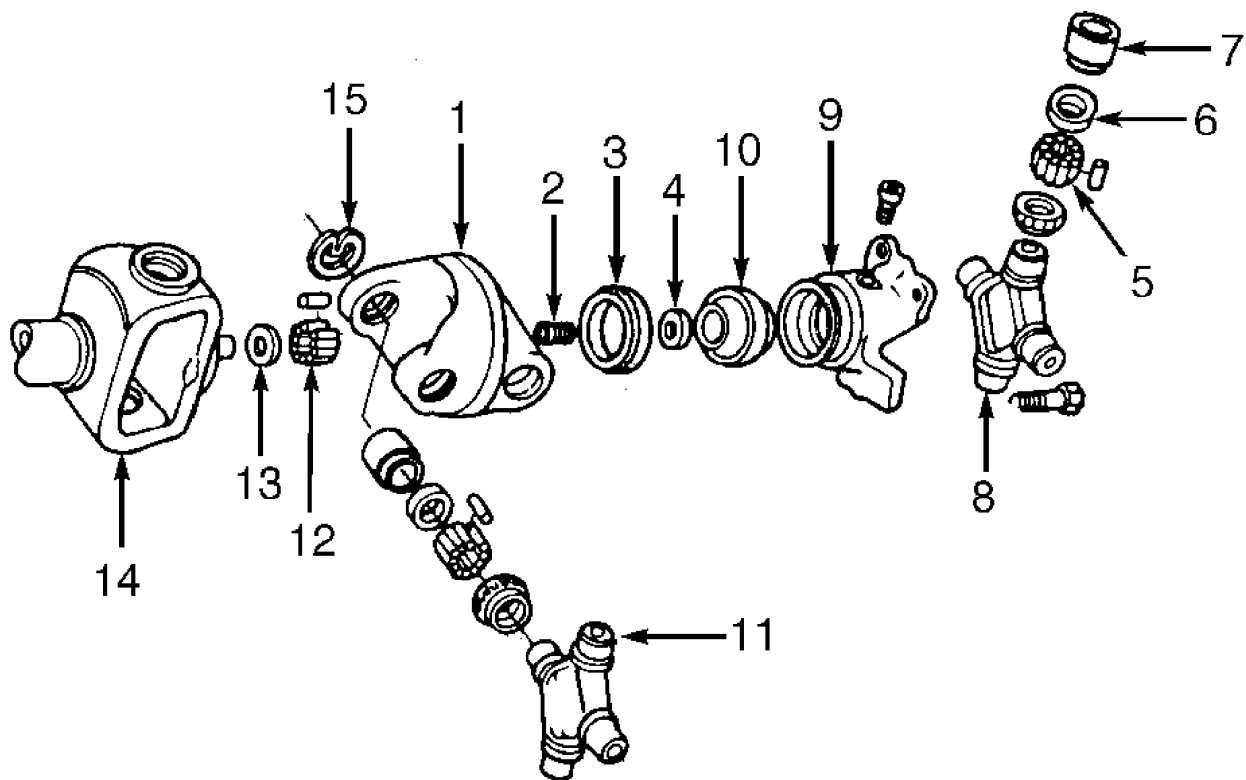
1993 Jeep Cherokee

1993 Drive Axles - Drive Shafts & Universal Joints

Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## DESCRIPTION

Drive shafts are balanced, one-piece, tubular steel shafts with universal joints at each end. Single Cardan universal joints contain a spider, 4 bearing caps with needle bearings, seals and clips. Double Cardan universal joints contains 2 spiders joined together, 8 bearing caps with needle bearings, seals and clips. See Fig. 1.



- |                         |                 |                      |
|-------------------------|-----------------|----------------------|
| 1. Link Yoke            | 6. Seal         | 11. Front Spider     |
| 2. Socket Spring        | 7. Bearing Cap  | 12. Needle Bearings  |
| 3. Socket Ball Retainer | 8. Rear Spider  | 13. Thrust Washer    |
| 4. Thrust Washer        | 9. Socket Yoke  | 14. Drive Shaft Yoke |
| 5. Needle Bearings      | 10. Socket Ball | 15. Retaining Clip   |

92A21840

Fig. 1: Exploded View Of Double Cardan Universal Joint  
Courtesy of Chrysler Corp.

## INSPECTION

## VIBRATION

### Tires & Wheels

Check tire inflation and wheel balance. Check for foreign objects in tread, damaged tread, mismatched treads or tire sizes. Check for tires that are out of round. Replace or repair as necessary.

### Engine & Transmission Mounts

Tighten mounting bolts. Replace mounts if soft or separated.

### Drive Shaft

Check shaft for damage or dents. Check for undercoating on shaft. If present, clean shaft.

### Universal Joints

Check for defective or damaged "U" joints. Check for loose bolts and worn bearings.

## DRIVE SHAFT RUNOUT

Remove any dirt from area around shaft where dial indicator is placed. Measure shaft runout about 3" from weld-seam on each end of shaft. With dial indicator mounted perpendicular to drive shaft, rotate shaft several times. Record runout measurement. Repeat the procedure at the opposite end and center of the drive shaft. See DRIVE SHAFT RUNOUT table. If runout is not equal to or less than specification, replace drive shaft.

DRIVE SHAFT RUNOUT TABLE

Application	In. (mm)
Front & Rear of Shaft .....	.010 (.25)
Center of Shaft .....	.015 (.38)

## DRIVE SHAFT ANGLE

NOTE: If drive shaft angle is excessive, vibration may result.

1) Check condition of springs, engine and transmission mounts. Ensure all mounting fasteners are tight. To ensure proper riding height, fuel tank should be full and vehicle should be empty of cargo. Raise and support vehicle so suspension bears weight of vehicle and wheels can rotate freely.

2) Remove clips from "U" joint cap bore. Ensure bearing caps are clean. Joint bearing cap to be measured must be straight down. Place Inclinator (J-23498-A) on bearing cap. Center bubble in sight glass. Record measurement. Rotate drive shaft 90 degrees. Repeat procedure. Subtract smaller figure from larger figure to obtain "U" joint angle.

3) Repeat procedure outlined in step 2) at opposite end of drive shaft. Compare "U" joint angle measurements. Difference of "U" joint angles MUST be within specification. See UNIVERSAL JOINT ANGLE table. If not with specification, adjust "U" joint angle. See SHAFT ANGLE under ADJUSTMENTS.

UNIVERSAL JOINT ANGLE TABLE

Application	Specification
Double Cardan Universal Joint .....	0-2.5°

Single Cardan "U" Joint ..... 0-1.5°

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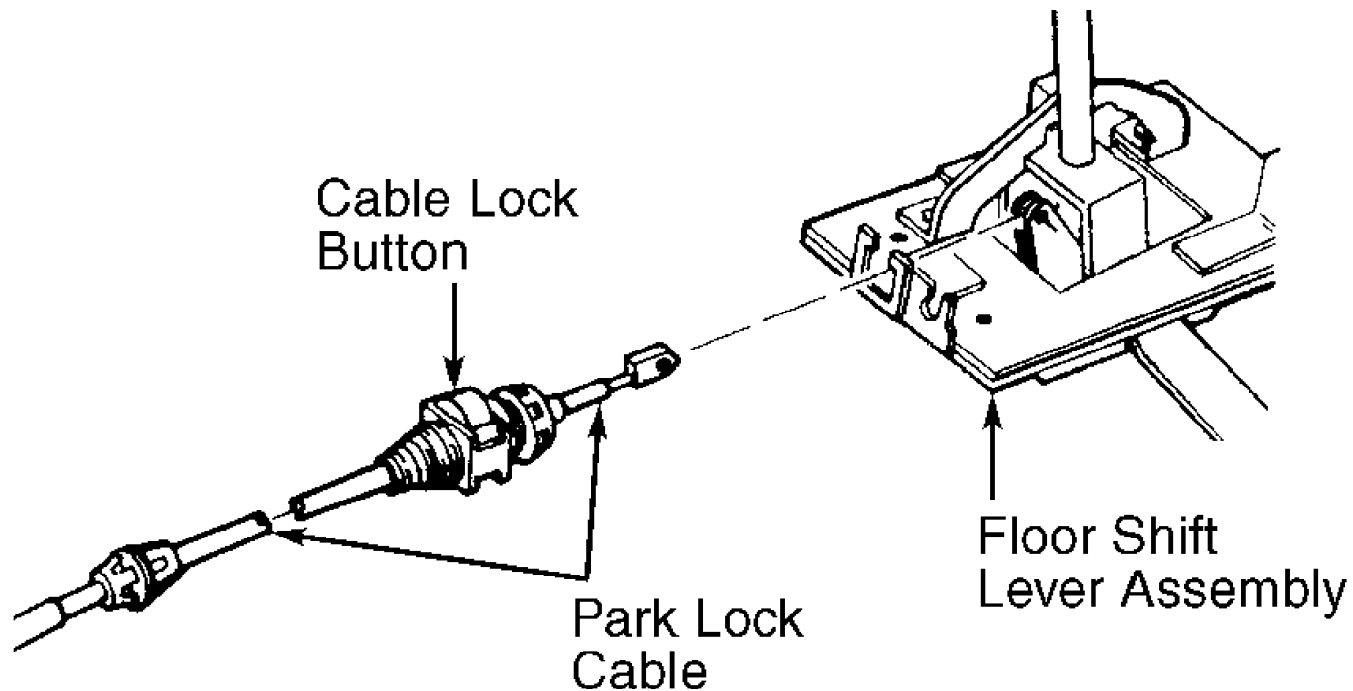
## ADJUSTMENTS

### SHAFT ANGLE

Front - Except Wrangler

1) Adjust drive pinion gear shaft angle "A" at the lower suspension arms with shims. Adding shims will decrease pinion gear shaft angle "A" but will increase caster angle. See Fig. 2.

2) Adjustment of angle "A" is more important than caster angle. When angle "A", angle "B" and vehicle height are correct, angle "C" will also be correct.



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Fig. 2: Front Drive Shaft Angle (Except Wrangler)  
Courtesy of Chrysler Corp.

Front - Wrangler

1) Raise vehicle and place jack stands under frame. Place a hydraulic jack under differential housing. Raise jack to support weight of axle.

2) Loosen spring "U" bolt nuts, and install tapered shims between springs and axle spring bracket to correct angle. Tighten spring "U" bolt nuts to 52 ft. lbs. (70 N.m) for Cherokee or 100 ft. lbs. (136 N.m) for all others.

NOTE: Adjustment procedure for rear shaft angle not available from manufacturer.

## OVERHAUL

NOTE: If joints are rusted or corroded, apply penetrating oil before disassembly.

## SINGLE CARDAN UNIVERSAL JOINT

### Disassembly

Scribe or paint marks on yokes and drive shaft for reassembly reference. Remove bearing cap retainer clips. Using sockets and vise as a press, remove bearing caps retaining spider to drive shaft and yoke. Remove spider. Inspect caps for cracks or defective needle bearings. Check spider for scoring or excessive wear. If defective, replace complete unit.

CAUTION: DO NOT place shaft or slip yoke tube in vise. Clamp only the forged portions in vise.

### Reassembly

1) Clean universal joint bores and yoke. Apply grease to yoke bores, bearing caps, bearings and spider contact surfaces.

2) Place spider into yoke and tap bearing cap, seal and bearings into yoke far enough to hold spider. Place a socket (smaller than cap) on side cap and place in vise.

3) Tighten vise until caps are seated in yoke. Rotate spider to make sure no binding occurs. Install cap clips and repeat procedure on remaining caps.

## DOUBLE CARDAN UNIVERSAL JOINT

NOTE: Double cardan universal joints are not serviceable. If defective, replace as an assembly.

### Disassembly

1) Scribe or paint marks on yokes and drive shaft for reassembly reference. Remove bearing cap retainer clips. Using sockets and vise as a press, remove bearing caps retaining front spider to link yoke. Remove drive shaft yoke from link yoke. See Fig. 1.

2) Remove bearing caps retaining rear spider in link yoke. Remove rear spider and socket yoke from link yoke. Remove bearing caps retaining front spider in drive shaft yoke. Remove front spider from drive shaft yoke.

### Inspection

Check all component for cracks, scores and excessive looseness. If any defect is found, replace complete "U" joint assembly.

### Reassembly

1) Ensure alignment of reference marks made during disassembly. Use extreme pressure (EP) lithium grease to aid in assembly. Place bearing caps on both ends of rear spider and secure with tape. Spider will mate with transfer case yoke. Assemble socket yoke and rear spider.

2) Install rear spider and socket yoke in link yoke. Insert bearing caps in yoke bores. Using sockets and a vise, press caps into bores. Install retaining clips. Install front spider in drive shaft yoke. Insert bearing caps in yoke bores. Press caps into bores. Install retaining clips.

3) Install thrust washer on drive shaft yoke. Align and install ball socket on drive shaft yoke. Install front spider in link yoke. Insert bearing caps in yoke bores. Press caps into bores. Install retaining clips. Check "U" joint for binding. Install drive shaft.

# **\* DRIVETRAIN SYSTEMS UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

Drivetrain/Transmission Motorist Assurance Program  
Standards For Automotive Repair

All Makes and Models

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

### **CONTENTS**

OVERVIEW OF MOTORIST ASSURANCE PROGRAM  
OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

Drive/Power Train Assemblies

AUTOMATIC TRANSMISSION/TRANSAXLE ASSEMBLIES  
DIFFERENTIAL AND FINAL DRIVE ASSEMBLIES  
MANUAL TRANSMISSION/TRANSAXLE ASSEMBLIES  
TRANSFER CASE ASSEMBLIES

Drive/Power Train Components

ACTUATORS (ELECTRICAL)  
ACTUATORS (VACUUM)  
AXLES  
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BELL HOUSINGS  
BUSHINGS (EXTERNAL)  
CABLES (SPEEDOMETER)  
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CLUTCH SLAVE CYLINDERS (CONVENTIONAL OR EXTERNAL)  
COMPANION FLANGES  
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COOLER LINES  
COOLERS  
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DIP STICKS (FLUID LEVEL INDICATORS)  
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EXCITER RINGS  
FILLER TUBES  
FILTERS AND SCREENS

FLANGES  
FLEX PLATES  
FLUID LEVEL INDICATORS  
FLUIDS AND LUBRICANTS  
FLYWHEELS  
FORCE MOTORS  
GUIDES  
HALF SHAFTS  
HOSES, LINES AND TUBES  
HOUSINGS (BELL, CASE, TAIL (EXTENSION) AND AUXILIARY)  
INTERMEDIATE SHAFT SUPPORT BEARINGS  
KEY INTERLOCK SYSTEMS  
LIMITED SLIPS  
LINES  
LINKAGES (EXTERNAL)  
LOCKING HUB ASSEMBLIES  
LOCKING HUB CONTROL KNOBS  
LUBRICANTS  
METAL-CLAD SEALS  
METALASTIC JOINTS  
MODULATOR PINS  
MODULATORS  
MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION)  
ODOMETER DRIVES (MECHANICAL)  
ODOMETER HEADS (MECHANICAL)  
OIL PANS  
PANS  
PILOT HOLES  
PRESSURE PLATES  
PRESSURE SWITCHES  
RACES  
RUBBER JOINTS (METALASTIC)  
SCREENS  
SEALS  
SEALS (METAL-CLAD)  
SELECTOR INTERLOCK SYSTEMS  
SERVOS  
SHIFT INTERLOCK SYSTEMS (SELECTOR AND KEY INTERLOCK SYSTEMS)  
SENSORS  
SIDE COVERS  
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SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE)  
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SPEEDOMETER/ODOMETER DRIVES (MECHANICAL)  
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SPEEDOMETERS AND ODOMETERS (ELECTRONIC)  
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TONE WHEELS  
TOOTHED RINGS (TONE WHEELS)  
TORQUE CONVERTERS  
TRANSAXLE MOUNTS  
TRANSDUCERS (TRANSMISSION)  
TRANSMISSION COOLERS  
TRANSMISSION MOUNTS  
TRANSMISSION PANS  
TRANSMISSION RANGE INDICATORS (PRNDL)  
TUBES  
UNIVERSAL JOINTS (CARDON OR CROSS TYPE)  
VACUUM CONTROLS  
VACUUM HOSES  
VACUUM MOTORS  
VACUUM-OPERATED SWITCHES

VEHICLE SPEED SENSORS  
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WHEEL ATTACHMENT HARDWARE  
WHEEL SPEED SENSORS  
WIRING HARNESES AND CONNECTORS  
YOKES AND SLIP YOKES

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW OF MOTORIST ASSURANCE PROGRAM**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles—through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection were recently published. Further, revisions to all of these inspection communication standards are continually republished. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method



has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

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## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

#### **Example:**

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

#### **Example:**

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

#### Reasons to Require Repair or Replacement

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

#### Reasons to Suggest Repair or Replacement

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

## **DRIVE/POWER TRAIN ASSEMBLIES**

### **SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION**

NOTE: Whenever transmission or drivetrain service is performed that affects the suspension alignment, for example, removing the engine cradle, it is required that the alignment be checked and corrected if necessary.

## AUTOMATIC TRANSMISSION/TRANSAXLE ASSEMBLIES

### AUTOMATIC TRANSMISSION/TRANSAXLE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1) .....	A .....	(2) Require repair or replacement of the automatic transmission/transaxle assembly.
(1) - It is Required that the torque converter and all other failure related components be inspected for cause and condition.		
(2) - For components not requiring removal of the assembly, refer to the component listing in this document.		

## DIFFERENTIAL AND FINAL DRIVE ASSEMBLIES

NOTE: Does not include half shafts.

### DIFFERENTIAL AND FINAL DRIVE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1) .....	A ...	Require repair or replacement of the differential assembly.
(1) - For components not requiring removal of the assembly, refer to the component listing in this document.		

## MANUAL TRANSMISSION/TRANSAXLE ASSEMBLIES

### MANUAL TRANSMISSION/TRANSAXLE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1) .....	A ...	Require repair or replacement of the manual transmission/transaxle assembly.
(1) - For components not requiring removal of the assembly,		

refer to the component listing in this document.

## TRANSFER CASE ASSEMBLIES

### TRANSFER CASE ASSEMBLY INSPECTION

Condition	Code	Procedure
Any internal component failure that requires removal of the assembly from the vehicle for service. (1) .....	A ...	Require repair or replacement of the transfer case differential assembly.

(1) - For components not requiring removal of the assembly, refer to the component listing in this document.

## DRIVE TRAIN/COMPONENTS

The conditions listed for the components included in this section assume that the problem has been isolated to the specific component through proper testing.

### ACTUATORS (ELECTRICAL)

#### ACTUATOR (ELECTRICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted, affecting performance ..	A .....	(1) Require repair or replacement.
Connector melted, not affecting performance ..	2 .....	(1) Suggest repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	A .....	(2) Require replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Out of adjustment .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	1 .....	(1) Suggest repair or

					replacement.
Terminal corroded, affecting performance	..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance	..	1	..	Suggest repair or replacement.	
Terminal loose, affecting performance	.....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance	..	1	..	Suggest repair or replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.

## ACTUATORS (VACUUM)

### ACTUATOR (VACUUM) INSPECTION

Condition		Code		Procedure
Attaching hardware broken	.....	A	...	Require repair or replacement of hardware.
Attaching hardware missing	.....	C	.....	Require replacement of hardware.
Attaching hardware not functioning	.....	A	..	Require repair or replacement of hardware.
Connector broken	.....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking	.....	A	..	Require repair or replacement.
Connector melted, affecting performance	..	A	.....	(1) Require repair or replacement.
Connector melted, not affecting performance	..	2	.....	(1) Suggest repair or replacement.
Connector missing	.....	C	.....	Require replacement.
Inoperative	.....	A	.....	(2) Require replacement.
Leaking (vacuum)	.....	A	..	Require repair or replacement.
Linkage bent, affecting performance	.....	A	...	Require repair or replacement of linkage.
Linkage bent, not affecting performance	..	2	...	Suggest repair or replacement of linkage.
Linkage binding, affecting performance	.....	A	...	Require repair or replacement of linkage.
Linkage binding, not affecting performance	..	1	...	Suggest repair or replacement of linkage.
Linkage broken		A		Require repair or replacement of linkage.
Linkage loose, affecting performance	.....	A	...	Require repair or replacement of linkage.
Linkage loose, not affecting performance	..	1	...	Suggest repair or replacement of linkage.

Linkage missing .....	C	.....	Require replacement.
Linkage noisy .....	2	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	..	Suggest repair or replacement.
Out of adjustment .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.

## AXLES

### AXLE INSPECTION

Condition	Code	Procedure
Bent .....	A	..... Require replacement.
Broken .....	A	..... Require replacement.
End play exceeds specifications .....	B	.. Require repair or replacement.
Flange bent .....	A	..... Require replacement.
Flange threads stripped ..	A	.. Require repair or replacement.
Twisted .....	A	..... Require replacement.
Worn, affecting performance .....	A	..... Require replacement.

## BEARINGS AND RACES

NOTE: When replacing or repacking bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

### BEARING AND RACE INSPECTION

Condition	Code	Procedure
Bearing end-play exceeds specifications .....	B	.. Require adjustment of bearing, if possible. If proper adjustment cannot be obtained, require replacement of bearing assembly.
Bearing rollers, balls or races are worn, pitted, or		

feel rough when rotated as an assembly .....	B	..	Require replacement of bearing assembly.
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## BELL CRANKS

### BELL CRANK INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bent .....	A	.. Require repair or replacement.
Broken .....	A	.. Require repair or replacement.
Cracked .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Worn, affecting performance .....	A	.. Require repair or replacement.

## BELL HOUSINGS

See HOUSINGS (BELL, CASE, TAIL (EXTENSION) AND AUXILIARY) .

## BUSHINGS (EXTERNAL)

### BUSHING (EXTERNAL) INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B	... Require repair or replacement of bent part if available; otherwise, replace bushing.
Attaching hardware broken .....	A	... Require replacement of broken part if available; otherwise, replace bushing.
Attaching hardware corroded, affecting structural integrity ...	A	. Require replacement of corroded part if available; otherwise, replace bushing.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part if available; otherwise, replace bushing.
Attaching hardware loose .....	A	... Require repair or replacement of loose part if available; otherwise, replace bushing.
Attaching hardware missing .....	C	.. Require replacement of missing part if available; otherwise, replace bushing.

Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads if available; otherwise, replace bushing.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads if available; otherwise, replace bushing.
Binding .....	A	..	Require repair or replacement.
Contaminated .....	1	.....	Suggest replacement.
Deteriorated, affecting performance .....	A	..	Require repair or replacement.
Distorted, affecting performance .....	A	..	Require repair or replacement.
Missing .....	A	.....	Require replacement.
Noisy .....	2	.....	(1) Further inspection required.
Rubber separating from internal metal sleeve on bonded bushing .....	A	.....	Require replacement.
Seized .....	A	.....	Require replacement.
Shifted (out of position) .....	B	..	Require repair or replacement.
Split .....	A	.....	Require replacement.
Surface cracking (weather- checked) .....	..	.....	No service suggested or required.
Worn, affecting performance .....	A	..	Require repair or replacement.
Worn close to the end of its useful life .....	1	.....	Suggest replacement.

(1) - If noise isolated to bushing, suggest repair or replacement.

CAUTION: Use only approved lubricant on rubber bushings.  
Petroleum-based lubricants may damage rubber bushings.

## CABLES (SPEEDOMETER)

### CABLE (SPEEDOMETER) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bent .....	A	.. Require repair or replacement.
Binding .....	A	.. Require repair or replacement.
Bracket bent, affecting performance .....	A	.. Require repair or replacement.
Bracket bent, not affecting performance ..	..	..... No service suggested or



					required.
Bracket broken, affecting performance .....	A	.....	Require replacement.		
Bracket broken, not affecting performance ..	..	.....	No service suggested or required.		
Bracket corroded, affecting performance ..	A	..	Require repair or replacement.		
Bracket corroded, not affecting performance ..	2	..	Suggest repair or replacement.		
Bracket cracked, affecting performance .....	A	..	Require repair or replacement.		
Bracket cracked, not affecting performance ..	1	..	Suggest repair or replacement.		
Bracket loose, affecting performance .....	A	..	Require repair or replacement.		
Bracket loose, not affecting performance ..	1	..	Suggest repair or replacement.		
Bracket missing .....	C	.....	Require replacement.		
Broken .....	A	.....	Require replacement.		
Cracked .....	A	..	Require repair or replacement.		
Disconnected .....	A	..	Require repair or replacement.		
Kinked .....	A	..	Require repair or replacement.		
Melted .....	A	.....	(1) Require repair or replacement.		
Missing .....	C	.....	Require replacement.		
Noisy .....	2	..	Suggest repair or replacement.		
Routed incorrectly .....	2	.....	Suggest repair.		
Seized .....	A	..	Require repair or replacement.		

(1) - Determine cause and correct prior to repair or replacement of part.

## CABLES (TV, DETENT AND SHIFT)

### CABLE (TV, DETENT AND SHIFT) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bent .....	A	.. Require repair or replacement.
Binding .....	A	.. Require repair or replacement.
Bracket bent, affecting performance .....	A	.. Require repair or replacement.
Bracket bent, not affecting performance ..	..	..... No service suggested or required.
Bracket broken, affecting performance .....	A	..... Require replacement.
Bracket broken, not affecting performance ..	..	..... No service suggested or required.
Bracket corroded, affecting performance ..	A	.. Require repair or replacement.

Bracket corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A	..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket loose, affecting performance .....	A	..	Require repair or replacement.
Bracket loose, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket missing .....	C	.....	Require replacement.
Broken .....	A	.....	Require replacement.
Cracked .....	A	..	Require repair or replacement.
Disconnected .....	A	..	Require repair or replacement.
Frayed .....	A	.....	Require replacement.
Kinked .....	A	..	Require repair or replacement.
Melted .....	A	.....	(1) Require repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	..	Suggest repair or replacement.
Out of adjustment .....	B	.....	(2) Require repair or replacement.
Routed incorrectly .....	2	.....	Suggest repair.
Seized .....	A	..	Require repair or replacement.
Self-adjuster inoperative .....	A	..	Require repair or replacement of self-adjuster.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Cable replacement is required if it cannot be adjusted within specifications.

## CARRIER BEARINGS

See INTERMEDIATE SHAFT SUPPORT BEARINGS.

## CLUTCH CABLES AND CABLE HOUSINGS

### CLUTCH CABLE AND CABLE HOUSING INSPECTION

Condition	Code	Procedure
Broken .....	A	..... Require replacement.
Cable bent .....	A	..... Require replacement.
Cable binding .....	A	.. Require repair or replacement.
Cable mounting loose ....	B	.. Require repair or replacement.
Cable out of adjustment .	B	.. Require repair or replacement.
Frayed .....	B	..... Require replacement.
Housing heat-damaged ....	1	..... Suggest replacement.
Missing .....	C	..... Require replacement.
Noisy .....	2	.. Suggest repair or replacement.
Seized .....	A	..... Require replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Worn, affecting performance .....	A	..... Require replacement.

## CLUTCH DISCS (MANUAL TRANSMISSION)

### CLUTCH DISC (MANUAL TRANSMISSION) INSPECTION

Condition	Code	Procedure
Backing plate cracked ...	A	Require replacement.
Broken .....	A	Require replacement.
Contaminated with oil ...	A	Require replacement.
Damper cushion broken ...	A	Require replacement.
Damper cushion collapsed .....	A	Require replacement.
Damper spring collapsed .	A	Require replacement.
Damper spring missing ..	C	(1) Require replacement.
Friction material cracked through .....	B	Require replacement.
Friction material flaking or chunking .....	B	Require replacement.
Friction material surface cracking .....	B	No service suggested or required.
Grooved .....	B	No service suggested or required unless the pressure plate or flywheel is being resurfaced or replaced. In this case, replacement of clutch disc is required.
Ridged .....	B	No service suggested or required unless the pressure plate or flywheel is being resurfaced or replaced. In this case, replacement of clutch disc is required.
Splines worn, affecting performance .....	A	Require replacement.
Warped .....	A	Require replacement.
Wear exceeds specifications (where applicable) .....	B	Require replacement.
Worn close to the end of its useful life .....	1	Suggest replacement.
Worn, affecting performance .....	A	Require replacement.

(1) - Not all clutch discs have springs in all spring chambers on the disc.

## CLUTCH FORKS

### CLUTCH FORK INSPECTION

Condition	Code	Procedure
Bent .....	B	Require replacement.
Broken .....	A	Require repair or replacement.
Cracked .....	B	Require repair or replacement.
Worn close to the end of its useful life .....	1	Suggest replacement.
Worn, affecting performance .....	A	Require replacement.

## CLUTCH LINKAGES (MECHANICAL)

See LINKAGES (EXTERNAL) .

## CLUTCH MASTER CYLINDERS

### CLUTCH MASTER CYLINDER INSPECTION

Condition	Code	Procedure
Cover gasket distorted ..	A ....	Require replacement of cover gasket.
Cover gasket gummy .....	A ....	Require replacement of cover gasket.
Cylinder leaking fluid from rear of bore .....	A ..	Require repair or replacement.
Cylinder leaking fluid internally .....	A .....	Require replacement.
Dust boot missing .....	C .....	Require replacement of dust boot.
Dust boot punctured .....	A .....	Require replacement of dust boot.
Dust boot torn .....	A .....	Require replacement of dust boot.
Fluid level incorrect ...	B .	Require fluid level adjustment.
Housing damaged, affecting performance .....	A ..	Require repair or replacement.
Master cylinder has residue in reservoir (make parallel w/brakes when they are done) ....	2 .....	(1) Further inspection required.
Threads damaged .....	A .....	Require repair replacement
Threads stripped (threads missing) .....	A .....	Require replacement.
(1) - DO NOT replace master cylinder unless it exhibits conditions listed for replacement. You may suggest fluid change according to OEM service intervals.		

## CLUTCH PEDALS

### CLUTCH PEDAL INSPECTION

Condition	Code	Procedure
Bent, affecting performance .....	A ..	Require repair or replacement.
Broken .....	A ..	Require repair or replacement.
Pedal pad missing .....	C .....	Require replacement of pedal pad.
Pivot bushings worn, affecting performance ..	A ....	Require replacement of pivot bushings.

## CLUTCH PIVOTS

### CLUTCH PIVOT INSPECTION

Condition	Code	Procedure
Bent .....	A .....	Require replacement.
Broken .....	A ..	Require repair or replacement.
Cracked .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Worn close to the end of its useful life .....	1 .....	Suggest replacement.
Worn, affecting performance .....	A .....	Require replacement.

## CLUTCH PRESSURE PLATES

See PRESSURE PLATES.

## CLUTCH RELEASE BEARINGS

### CLUTCH RELEASE BEARING INSPECTION

Condition	Code	Procedure
Collar broken .....	A .....	Require replacement.
Cracked .....	A .....	Require replacement.
Rough when rotated as an assembly .....	B .....	Require replacement.
Seized .....	A .....	Require replacement.
Wear exceeds specifications .....	B .....	Require replacement.
Worn close to the end of its useful life .....	1 .....	Suggest replacement.
Worn, affecting performance .....	A .....	Require replacement.

## CLUTCH SLAVE CYLINDERS (CONCENTRIC)

### CLUTCH SLAVE CYLINDER (CONCENTRIC) INSPECTION

Condition	Code	Procedure
Bearing rough when rotated as an assembly .....	B .....	Require replacement.
Bearing seized .....	A .....	Require replacement.
Bleeder pipe leaks .....	A ..	Require repair or replacement.
Carrier assembly worn, affecting performance ..	A .....	Require replacement.
Collar broken .....	A .....	Require replacement.
Cracked .....	A .....	Require replacement.
Housing leaks .....	A .....	Require replacement.
Inoperative .....	A .....	Require replacement.
Release binding .....	A .....	Require replacement.
Spring broken .....	A .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Worn, affecting performance .....	A .....	Require replacement.

## CLUTCH SLAVE CYLINDERS (CONVENTIONAL OR EXTERNAL)

### CLUTCH SLAVE CYLINDER (CONVENTIONAL OR EXTERNAL) INSPECTION

Condition	Code	Procedure
Binding .....	A ..	Require repair or replacement.
Bleeder port damaged (not repairable) .....	A .....	(1) Require replacement.
Bleeder port damaged (repairable) .....	A .....	(1) Require repair.
Bleeder screw broken off in slave cylinder .....	A .....	(1) Require replacement.
Bleeder screw seized ....	A .....	(2) Require replacement.
Bore corroded (pitted) ..	B .....	Require replacement.
Bore grooved .....	A .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

(1) - Only required if the hydraulic system must be opened.  
(2) - Seized is defined as a bleeder screw that cannot be removed after a practical attempt at removing it has been made.

## COMPANION FLANGES

See YOKES AND SLIP YOKES.

## CONNECTORS

See WIRING HARNESSSES AND CONNECTORS.

## COOLER BYPASS VALVES

### COOLER BYPASS VALVE INSPECTION

Condition	Code	Procedure
Inoperative .....	A .....	Require replacement.
Installed incorrectly ...	A .....	Require repair.
Leaking .....	A ..	Require repair or replacement.
Restricted .....	A ..	Require repair or replacement.

## COOLER LINES

### COOLER LINE INSPECTION

Condition	Code	Procedure
Abrasion damage, affecting structural integrity ...	A ..	Require repair or replacement.
Abrasion damage, not affecting structural integrity .....	.. .....	No service suggested or required.
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.

Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Clamp corroded, not reusable .....	1	.....	Suggest replacement.
Connected incorrectly ...	A	.....	Require repair.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Corroded, not affecting structural integrity ...	..	.....	No service suggested or required.
Cracked .....	A	..	Require repair or replacement.
Fitting type incorrect (such as compression fitting) .....	B	.....	Require replacement.
Flange leaking .....	A	..	Require repair or replacement.
Insufficient clamping force, allowing hose to leak .....	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Melted .....	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Outer covering damaged to the extent that the inner fabric is visible .....	A	.....	Require replacement.
Protective sleeves damaged .....	2	.	Suggest replacement of sleeves.
Protective sleeves missing .....	C	.	Require replacement of sleeves.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Routed incorrectly .....	2	.....	Require repair.
Swollen .....	1	.....	Suggest replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Type incorrect .....	1	..	Suggest repair or replacement.

## COOLERS

See TRANSMISSION COOLERS.

## CV JOINTS

### CV JOINT INSPECTION

Condition	Code	Procedure
Bearing, bushing or seal surface worn, affecting performance .....	A	.. Require repair or replacement.
Boot clamp broken .....	A	... Require repair or replacement of clamp.
Boot clamp loose .....	A	... Require repair or replacement of clamp.
Boot clamp missing .....	C	... Require repair or replacement of clamp.
Boot leaking .....	A	. Require replacement of CV boot.
Boot surface cracked,		

not leaking .....	2	.	Suggest replacement of CV boot.
Cage broken .....	A	...	Require repair or replacement of CV joint.
Housing damaged to the extent that it no longer performs its intended function .....	A	.....	(1) Require repair or replacement of CV joint.
Housing worn to the extent that it no longer performs its intended function ..	A	.....	(1) Require repair or replacement of CV joint.
Holes elongated .....	A	.....	Require replacement.
Internal parts binding ..	A	..	Require repair or replacement.
Internal parts worn .....	A	..	Require repair or replacement.
Lubricant missing .....	C	...	Require cleaning, inspection, and repacking of CV joint.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - Housing assembly may appear blue in color from normal manufacturing process of heat-treating the housing.

## DIP STICK TUBES

### DIP STICK TUBE INSPECTION

Condition	Code	Procedure
Broken .....	A ..	Require repair or replacement.
Checkball missing .....	C ..	Suggest repair or replacement.
Cracked .....	A ..	Require repair or replacement.
Hold down bracket broken .....	A ..	Require repair or replacement.
Hold down bracket missing .....	C .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## DIP STICKS (FLUID LEVEL INDICATORS)

### DIP STICK (FLUID LEVEL INDICATOR) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Compressed .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Modified .....	A .....	Require replacement.
Stretched .....	A ..	Require repair or replacement.

## DOWEL PINS, GUIDES AND PILOT HOLES

### DOWEL PIN, GUIDE AND PILOT HOLE INSPECTION



Condition	Code	Procedure
Application incorrect ...	B ..	Require repair or replacement.
Cracked .....	A ..	Require repair or replacement.
Distorted .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Positioned incorrectly ..	B ..	Require repair or replacement.
Stepped .....	A ..	Require repair or replacement.
Worn to the extent that it no longer performs its intended function .....	A ..	Require repair or replacement.

## DRIVE SHAFT FLANGES

See COMPANION FLANGES.

## DRIVE SHAFTS AND HALF SHAFTS

### DRIVE SHAFT AND HALF SHAFT INSPECTION

Condition	Code	Procedure
Balance weight missing ..	C ..	Require repair or replacement.
Bearing cap bore distorted .....	A ..	Require repair or replacement.
Bent .....	A .....	Require replacement.
Bolt holes elongated ....	A ..	Require repair or replacement.
Bushing or seal surface worn, affecting performance .....	A ..	Require repair or replacement.
Leaking through soft yoke plug .....	A ...	Require repair or replacement of soft yoke plug.
Out of balance .....	A ..	Require repair or replacement.
Retainer strap bent .....	A .....	Require replacement of retainer strap.
Slip yoke broken .....	A .....	Require replacement.
Splines worn, affecting performance .....	A .....	Require replacement.
Splines worn close to the end of their useful life .....	1 .....	Suggest replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
U-bolt damaged, affecting performance .....	A .	Require replacement of U-bolts.
Yoke damaged, affecting performance .....	A ..	Require repair or replacement.

## DUST BOOTS

NOTE: Does not include CV boots.

### DUST BOOT INSPECTION

Condition	Code	Procedure
Cracked, not leaking ....	1 .....	Suggest replacement.
Missing .....	C .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.

Torn ..... A ..... Require replacement.

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## ENGINE MOUNTS

See MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION) .

## EXCITER RINGS

See TOOTHED RINGS (TONE WHEELS) .

## FILLER TUBES

See DIP STICK TUBES.

## FILTERS AND SCREENS

### FILTER AND SCREEN INSPECTION

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Condition	Code	Procedure
At service interval .....	3 .....	Suggest replacement.
Bent .....	A ..	Require repair or replacement.
Exceeding service interval .....	3 .....	Suggest replacement.
Missing .....	C .....	Require replacement.
Near service interval ...	3 .....	Suggest replacement.
Restricted .....	A .....	(1) Require repair or replacement.
Torn .....	A .....	Require replacement.
Worn, affecting performance (metal or nylon screen type) .....	A ..	Require repair or replacement.

(1) - Further inspection may be required to determine the source of restriction or contamination.

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## FLANGES

See COMPANION FLANGES.

## FLEX PLATES

### FLEX PLATE INSPECTION

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Condition	Code	Procedure
Bent, affecting performance .....	A .....	Require replacement.
Bent, not affecting performance .....	.. .....	No service suggested or required.
Bolt or stud holes elongated .....	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Cracked .....	A .....	Require replacement.
Ring gear worn close to the end of its useful life .....	1 .....	Suggest replacement.
Ring gear worn to the extent that it no longer		

performs its intended function .....	A .....	Require replacement.
Weights missing .....	A .....	Require replacement.

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## FLUID LEVEL INDICATORS

See DIP STICKS (FLUID LEVEL INDICATORS) .

## FLUIDS AND LUBRICANTS

### FLUID AND LUBRICANT INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	(1) Require replacement.
At service interval .....	3 .....	Suggest replacement.
Beyond service interval .	3 .....	Suggest replacement.
Burned .....	.. .....	(2) Further inspection required.
Contaminated, for example, fluid other than hydraulic fluid present .....	A or B ....	(3) (4) Require service.
Exceeding service interval .....	3 .....	Suggest replacement.
Hydraulic fluid incorrect .....	B .....	(5) Require service.
Level incorrect .....	B .....	Require correction of fluid level.
Near service interval ...	3 .....	Suggest replacement.
Rubber master cylinder cover gasket distorted and gummy .....	A .....	(3) Require service.
Varnished .....	.. .....	(6) Further inspection required.

- (1) - Determine and correct cause.
  - (2) - Fluid that is burned indicates a serious problem. Determine and correct the cause.
  - (3) - If a fluid other than hydraulic fluid is present in the hydraulic system which DOES affect the rubber parts, the required service is to: 1) remove all components having rubber parts from the system, 2) flush lines with denatured alcohol or hydraulic cleaner, 3) repair or replace all components having rubber parts, and 4) bleed and flush with correct hydraulic fluid. (Code A)
  - (4) - If a fluid other than hydraulic fluid is present in the hydraulic system which DOES NOT affect the rubber parts, the required service is to flush and fill with the correct hydraulic fluid. (Code B)
  - (5) - If a fluid other than specification hydraulic fluid is present in the hydraulic system, the required service is to flush and fill with the correct hydraulic fluid.
  - (6) - Fluid that is varnished may indicate a serious problem. Determine and correct the cause.
- 

## FLYWHEELS

NOTE: Clutch disc replacement does not necessitate flywheel reconditioning, unless other conditions justify the reason to do so.

## FLYWHEEL INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Cracked (other than mounting area) .....	A .....	(1) Require resurfacing or replacement.
Cracks in mounting area .	B .....	Require replacement.
Hard spots .....	B ..	Require repair or replacement.
Ring gear broken .....	A .....	Require replacement of ring gear.
Ring gear teeth worn, affecting performance ..	A .....	Require replacement of ring gear.
Runout exceeds specifications .....	B ..	Require repair or replacement.
Scored .....	B ..	Require repair or replacement.
Surface cracks after resurfacing to manufacturer's minimum specifications .....	B .....	Require replacement.
Wear exceeds specifications .....	B .....	Require replacement.
Worn close to the end of its useful life .....	1 .....	Suggest replacement.
Worn, affecting performance .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
(1) - Some manufacturers allow slight surface cracking in the friction surface.		

## FORCE MOTORS

See ACTUATORS (ELECTRICAL) .

## GUIDES

See DOWEL PINS, GUIDES AND PILOT HOLES .

## HALF SHAFTS

See DRIVE SHAFTS AND HALF SHAFTS .

## HOSES, LINES AND TUBES

### HOSE, LINE AND TUBE INSPECTION

Condition	Code	Procedure
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Application incorrect ...	B	.....	Require replacement.
Connected incorrectly ...	A	.....	Require repair.
Corroded, not reusable ..	1	.....	Suggest replacement.
Cracked .....	A	.....	Require replacement.
Dry-rotted .....	1	..	Suggest repair or replacement.
Hard .....	1	..	Suggest repair or replacement.
Inner fabric (webbing) damaged .....	A	.....	Require replacement.
Insufficient clamping force, allowing hose to leak .....	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Maintenance intervals ...	3	.....	Suggest replacement.
Melted .....	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Outer covering damaged ..	1	.....	Suggest replacement.
Outer covering damaged to the extent that the inner fabric is visible .....	A	.....	Require replacement.
Protective sleeves damaged .....	2	.	Suggest replacement of sleeves.
Protective sleeves missing .....	2	.	Suggest replacement of sleeves.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Restricted, not affecting performance .....	2	..	Suggest repair or replacement.
Routed incorrectly .....	2	.....	Suggest replacement.
Safety clip missing .....	C	.....	Require replacement.
Spongy .....	1	..	Suggest repair or replacement.
Stripped .....	A	.....	Require replacement.
Swollen .....	B	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Type incorrect .....	1	..	Suggest repair or replacement.

## HOUSINGS (BELL, CASE, TAIL (EXTENSION) AND AUXILIARY)

### HOUSING (BELL, CASE, TAIL (EXTENSION) AND AUXILIARY) INSPECTION

Condition	Code	Procedure
Bearing race loose in bore .....	A	.. Require repair or replacement.
Broken, affecting performance .....	A	.. Require repair or replacement.
Cracked .....	A	.. Require repair or replacement.
Dowel pin holes worn, affecting performance ..	A	..... (1) Require repair or replacement.
Machined surfaces damaged, affecting performance ..	A	.. Require repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Worn, affecting performance .....	A	.. Require repair or replacement.

(1) - See DOWEL PINS, GUIDES AND PILOT HOLES.

## INTERMEDIATE SHAFT SUPPORT BEARINGS

### INTERMEDIATE SHAFT SUPPORT BEARING INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bearing rollers, balls or races are worn, pitted, noisy, or feel rough when rotated as an assembly .	A ..	Require replacement of bearing assembly.
Bracket bent, affecting performance .....	A ..	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A .....	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A ..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A ..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A ..	Require repair or replacement.
Bracket holes elongated, not affecting performances) .....	.. ..	No service suggested or required.
Bracket loose, affecting performance .....	A ..	Require repair or replacement.
Bracket loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket missing .....	C .....	Require replacement.
Cracked .....	.. ..	Require replacement.
Rough (brinelling, spalling) .....	A .....	Require replacement.
Rubber deteriorated, affecting performance ..	A .....	Require replacement.
Seized .....	A .....	Require replacement.

## KEY INTERLOCK SYSTEMS

See

SHIFT INTERLOCK SYSTEMS (SELECTOR AND KEY INTERLOCK SYSTEMS) .

## LIMITED SLIPS

See DIFFERENTIAL AND FINAL DRIVE ASSEMBLIES.

## LINES

See HOSES, LINES AND TUBES.

## LINKAGES (EXTERNAL)

### LINKAGE (EXTERNAL) INSPECTION

Condition	Code	Procedure
Components missing .....	C ..	Require replacement of missing components.
Linkage bent, affecting performance .....	A ...	Require repair or replacement of linkage.
Linkage bent, not affecting performance ..	2 ...	Suggest repair or replacement of linkage.
Linkage binding, affecting performance .....	A ...	Require repair or replacement of linkage.
Linkage binding, not affecting performance ..	1 ...	Suggest repair or replacement of linkage.
Linkage broken .....	A ...	Require repair or replacement of linkage.
Linkage loose, affecting performance .....	A ...	Require repair or replacement of linkage.
Linkage loose, not affecting performance ..	1 ...	Suggest repair or replacement of linkage.
Linkage missing .....	C .....	Require replacement.
Linkage noisy .....	2 ..	Suggest repair or replacement.
Out of adjustment .....	B ..	Require repair or replacement.
Worn to the extent that it no longer performs its intended function .....	A ..	Require repair or replacement.

## LOCKING HUB ASSEMBLIES

### LOCKING HUB ASSEMBLY INSPECTION

Condition	Code	Procedure
Inoperative .....	A .....	(1) Require repair or replacement.
Loose .....	A ..	Require repair or replacement.
Seized in any position ..	A ..	Require repair or replacement.

(1) - Inoperative includes intermittent operation.

## LOCKING HUB CONTROL KNOBS

### LOCKING HUB CONTROL KNOB INSPECTION

Condition	Code	Procedure
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Damaged, affecting performance .....	A	.....	Require replacement.
Missing .....	C	.....	Require replacement.
Worn, affecting performance .....	A	.....	Require replacement.

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## LUBRICANTS

See FLUIDS AND LUBRICANTS.

## METAL-CLAD SEALS

See SEALS.

## METALASTIC JOINTS

See RUBBER JOINTS (METALASTIC) .

## MODULATOR PINS

### MODULATOR PIN INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Missing .....	C	..... Require replacement.

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## MODULATORS

### MODULATOR INSPECTION

Condition	Code	Procedure
Bent, affecting performance .....	A	..... Require replacement.
Contaminated (water, fuel, etc.) .....	A	..... (1) Require replacement.
Housing cracked .....	A	..... Require replacement.
Inoperative .....	A	..... (2) Require replacement.
Leaking fluid externally .....	A	.. Require repair or replacement.
Leaking fluid internally .....	A	..... Require replacement.
Leaking vacuum .....	A	..... Require replacement.
Nipple broken .....	A	..... Require replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.

- (1) - Further inspection is required to determine the cause of the contamination.
- (2) - Inoperative includes intermittent operation or out of OEM specification.
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## MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION)

### MOUNT (ENGINE, TRANSAXLE AND TRANSMISSION) INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Broken .....	A .....	Require replacement.
Leaking (hydraulic mount) .....	A .....	Require replacement.
Mounting hole worn, affecting performance ..	A .....	Require replacement.
Mounting hole worn, not affecting performance ..	.. ..	No service suggested or required.
Rubber deteriorated, affecting performance ..	A .....	Require replacement.
Rubber deteriorated, not affecting performance ..	.. ..	No service suggested or required.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## ODOMETER DRIVES (MECHANICAL)

See SPEEDOMETER/ODOMETER DRIVES (MECHANICAL) .

## ODOMETER HEADS (MECHANICAL)

See SPEEDOMETER/ODOMETER HEADS (MECHANICAL) .

## OIL PANS

See TRANSMISSION PANS .

## PANS

See TRANSMISSION PANS .

## PILOT HOLES

See DOWEL PINS, GUIDES AND PILOT HOLES .

## PRESSURE PLATES

### PRESSURE PLATE INSPECTION

Condition	Code	Procedure
Balance weight missing ..	C .....	Require replacement.
Broken .....	A .....	Require replacement.
Contact surface distorted .....	B .....	Require replacement.
Cracks .....	B .....	Require replacement.
Fingers bent .....	A .....	Require replacement.
Hard spots .....	B .....	Require replacement.

Scored .....	B	.....	Require replacement.
Spring rate less than specifications .....	B	.....	Require replacement.
Worn, affecting performance .....	A	.....	Require replacement.
Worn beyond specifications .....	B	.....	Require replacement.
Worn close to the end of its useful life .....	1	.....	Suggest replacement.

## PRESSURE SWITCHES

See SWITCHES.

## RACES

See BEARINGS AND RACES.

## RUBBER JOINTS (METALASTIC)

These joints may be found on half and/or drive shafts. They are usually found on European vehicles featuring a three-lug drive flange. They may be equipped with a centering ball or pin.

### RUBBER JOINT (METALASTIC) INSPECTION

Condition	Code	Procedure
Drive flange bent .....	A	..... Require repair or replacement.
Drive flange damaged, affecting performance ..	A	..... Require replacement.
Rubber drive joint cracked .....	2	..... Suggest replacement.
Rubber drive joint damaged, affecting performance .....	A	..... Require replacement.
Rubber drive joint split between mounting holes .	A	..... Require replacement.
Rubber drive joint torn at mounting holes .....	A	..... Require replacement.
Rubber drive joint weather-cracked .....	..	..... No service suggested or required.

## SCREENS

See FILTERS AND SCREENS.

## SEALS

### SEAL INSPECTION

Condition	Code	Procedure
Leaking .....	A	..... (1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary. Check vent. A plugged

vent may force fluid past the seal.

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## SEALS (METAL-CLAD)

See SEALS.

## SELECTOR INTERLOCK SYSTEMS

See

SHIFT INTERLOCK SYSTEMS (SELECTOR AND KEY INTERLOCK SYSTEMS) .

## SERVOS

See ACTUATORS (VACUUM) .

## SHIFT INTERLOCK SYSTEMS (SELECTOR AND KEY INTERLOCK SYSTEMS)

See:

ACTUATORS (ELECTRICAL)

CABLES

LINKAGES (EXTERNAL)

SWITCHES

## SENSORS

### SENSOR INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	A .....	(2) Require repair or replacement.
Leaking (vacuum/fluid/air) .....	A .....	Require replacement.
Out of adjustment .....	B .....	(3) Further inspection required.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting		

performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of specification.
- (3) - Follow OEM recommended adjustment procedures. Repair or replace if out of specification.

## SIDE COVERS

See TRANSMISSION PANS.

## SLIP YOKES

See YOKES AND SLIP YOKES.

## SOLENOIDS

See:  
ACTUATORS (ELECTRICAL)  
ACTUATORS (VACUUM)

## SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE)

### SPEED SENSOR (ELECTRONIC WHEEL AND VEHICLE) INSPECTION

Condition	Code	Procedure
Air gap incorrect .....	B	..... (1) Require adjustment or replacement.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (2) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (3) Require repair or replacement.
Inoperative .....	B	..... (4) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Loose .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of		

specification .....	B	..	Require repair or replacement.
Sensor housing cracked ..	2	.....	Suggest replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead misrouted .....	B	....	Require re-routing according to vehicle manufacturer's specifications.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - If a sensor is not adjustable, further inspection is required to identify and correct cause.
- (2) - Determine cause and correct prior to repair or replacement of part.
- (3) - Determine source of contamination, such as metal particles or water. Require repair or replacement.
- (4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## SPEEDOMETER-DRIVEN GEAR HOUSINGS

See SPEEDOMETER/ODOMETER DRIVES (MECHANICAL) .

## SPEEDOMETER/ODOMETER DRIVES (MECHANICAL)

### SPEEDOMETER/ODOMETER DRIVE (MECHANICAL) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Inoperative .....	A	..... (1) Require replacement.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Teeth broken .....	A	.. Require repair or replacement.

Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Worn close to the end of its useful life .....	1	.....	Suggest replacement.
Worn, affecting performance .....	A	.....	Require replacement.

(1) - Inoperative includes intermittent operation.

## SPEEDOMETER/ODOMETER HEADS (MECHANICAL)

### SPEEDOMETER/ODOMETER HEAD (MECHANICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Lens broken .....	A	..... (1) Require repair or replacement.
Lens cloudy .....	2	..... (1) Suggest repair or replacement.
Lens missing .....	C	..... (1) Require repair or replacement.
Malfunctioning .....	A	..... (2) Require repair or replacement.
Noisy .....	2	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.

(1) - If lens is available as a separate part, require replacement of lens only.

(2) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.

## SPEEDOMETERS AND ODOMETERS (ELECTRONIC)

### SPEEDOMETER AND ODOMETER (ELECTRONIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack		

type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Leaking .....	A	.....	Require replacement.
Lens broken .....	A	.....	(2) Require repair or replacement.
Lens cloudy .....	2	.....	(2) Suggest repair or replacement.
Lens missing .....	C	.....	(2) Require repair or replacement.
Malfunctioning .....	A	.....	(3) Require repair or replacement.
Mechanical head noisy ...	2	..	Suggest repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - If lens is available as a separate part, require replacement of lens only.
- (3) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.

## SWITCHES

### SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Binding, affecting performance .....	A	.. Require repair or replacement.
Binding, not affecting performance .....	2	.. Suggest repair or replacement.
Broken .....	A	.. Require repair or replacement.
Burned, affecting performance .....	A	..... (1) Require repair or replacement.
Burned, not affecting performance .....	2	..... (1) Suggest repair or

				replacement.
Cracked, affecting performance .....	A	..	Require repair or replacement.	
Cracked, not affecting performance .....	1	..	Suggest repair or replacement.	
Leaking .....	A	..	Require repair or replacement.	
Malfunctioning .....	A	.....	(2) Require repair or replacement.	
Melted, affecting performance .....	A	.....	(1) Require repair or replacement.	
Melted, not affecting performance .....	2	.....	(1) Suggest repair or replacement.	
Missing .....	C	.....	Require replacement.	
Out of adjustment .....	B	..	Require repair or replacement.	
Terminal broken .....	A	..	Require repair or replacement.	
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.	
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance .....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.	
Won't return .....	A	..	Require repair or replacement.	
Worn .....	1	.....	Suggest replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Includes inoperative, intermittent operation, or failure to perform all functions.

## TONE WHEELS

See TOOTHED RINGS (TONE WHEELS).

## TOOTHED RINGS (TONE WHEELS)

If the toothed ring requires replacement and cannot be replaced as a separate component, replace the assembly of which the ring is a part.

### TOOTHED RING (TONE WHEEL) INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B	.. Require repair or replacement.
Bent .....	B	..... Require replacement.
Contaminated, affecting performance .....	A	.... Require repair. Identify and correct cause.
Cracked .....	B	..... Require replacement.
Loose .....	A	.... Require replacement of worn parts.
Missing .....	C	..... Require replacement.
Number of teeth		



incorrect .....	B	.....	Require replacement.
Teeth broken .....	A	.....	Require replacement.
Teeth damaged, affecting performance .....	A	.....	Require replacement.

## TORQUE CONVERTERS

### TORQUE CONVERTER INSPECTION

Condition	Code	Procedure
Converter clutch lock-up operation is faulty ....	A	..... Require replacement.
Cover shell damaged, affecting performance ..	A	..... Require replacement.
Does not meet stall speed specification .....	B	..... Require replacement.
End play exceeds specifications .....	B	..... Require replacement.
Hub broken .....	A	..... Require replacement.
Hub cracked .....	A	..... Require replacement.
Internal component failure .....	A	..... Require replacement.
Leaking .....	A	.. Require repair or replacement.
Pilot broken .....	A	..... Require replacement.
Pilot worn, affecting performance .....	A	..... Require replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Weights missing .....	C	..... Require replacement.

## TRANSAXLE MOUNTS

See MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION) .

## TRANSDUCERS (TRANSMISSION)

See SENSORS .

## TRANSMISSION COOLERS

### TRANSMISSION COOLER INSPECTION

Condition	Code	Procedure
Air flow obstruction ....	A	..... Require repair.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	.. Require repair or replacement of hardware.
Connection leaking .....	A	.. Require repair or replacement.
Contaminated .....	A	.. Require repair or replacement.
Corroded .....	1	.. Suggest repair or replacement.
Fins damaged, affecting		

performance .....	A	..	Require repair or replacement.
Fins damaged, not affecting performance .. ..	.....		No service suggested or required.
Internal restrictions ...	B	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	..	Require repair or replacement.
Tubes damaged, affecting performance .....	A	..	Require repair or replacement.
Tubes damaged, not affecting performance .. ..	.....		No service suggested or required.

## TRANSMISSION MOUNTS

See MOUNTS (ENGINE, TRANSAXLE AND TRANSMISSION) .

## TRANSMISSION PANS

### TRANSMISSION PAN INSPECTION

Condition	Code	Procedure
Bent, interfering with filter or other internal components .....	A	.. Require repair or replacement.
Leaking .....	A	.. Require repair or replacement.

## TRANSMISSION RANGE INDICATORS (PRNDL)

### TRANSMISSION RANGE INDICATOR (PRNDL) INSPECTION

Condition	Code	Procedure
Binding .....	A	.. Require repair or replacement.
Broken .....	A	.. Require repair or replacement.
Components missing .....	C	.. Require replacement of missing components.
Loose, affecting performance .....	A	.. Require repair or replacement.
Out of adjustment .....	A	..... Require repair.
Worn, affecting performance .....	A	.. Require repair or replacement.

## TUBES

See HOSES, LINES AND TUBES.

## UNIVERSAL JOINTS (CARDON OR CROSS TYPE)

### UNIVERSAL JOINT (CARDON OR CROSS TYPE) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.

Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Bearing cap distorted ...	B	.....	Require replacement.
Binding .....	A	.....	Require replacement.
Cross (trunion) worn, affecting performance ..	A	.....	Require replacement.
Double cardon centering ball damaged .....	A	.....	Require replacement.
Double cardon centering ball worn, affecting performance .....	A	.....	Require replacement.
Double cardon centering spring broken .....	A	.....	Require replacement.
Double cardon centering spring missing .....	C	.....	Require replacement.
Double cardon centering spring weak .....	A	.....	Require replacement.
End cap seal cracked ....	2	.....	Suggest replacement.
End cap seal missing ....	C	....	Require replacement of seal.
Grease fitting broken ...	A	.....	(1) Require replacement of grease fitting.
Grease fitting missing ..	C	.....	(2) Require replacement of grease fitting.
Rust-colored powder around end cap seals .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Worn, affecting performance .....	A	.....	Require replacement.
(1) - A broken grease fitting does not require replacement of the U-Joint.			
(2) - A missing grease fitting does not require replacement of the U-Joint.			

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## VACUUM CONTROLS

See ACTUATORS (VACUUM) .

## VACUUM HOSES

See HOSES, LINES AND TUBES .

## VACUUM MOTORS

See ACTUATORS (VACUUM) .

## VACUUM-OPERATED SWITCHES

See SWITCHES .

## VEHICLE SPEED SENSORS

See SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE) .

## VENTS

## VENT INSPECTION

Condition	Code	Procedure
Broken .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Plugged .....	A .....	(1) Require repair or replacement.

(1) - A plugged vent may force fluid past the seal.

## VIBRATION DAMPERS

### VIBRATION DAMPER INSPECTION

Condition	Code	Procedure
Broken .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Out of position .....	B ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## WHEEL ATTACHMENT HARDWARE

**NOTE:** For conditions noted below, also check conditions of wheel stud holes.

**CAUTION:** Proper lug nut torque is essential. Follow recommended torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

### WHEEL ATTACHMENT HARDWARE INSPECTION

Condition	Code	Procedure
Bent .....	A .....	Require replacement.
Broken .....	A .....	(1) Require replacement.
Loose .....	B ...	Require repair or replacement of affected component.
Lug nut installed backward .....	B ..	Require repair or replacement.
Lug nut mating surface dished .....	A .....	Require replacement of nut.
Lug nut mating type incorrect .....	B .....	Require replacement of nut.
Lug nut rounded .....	A .	(2) Require replacement of nut.
Lug nut seized .....	A .	(2) Require replacement of nut.
Stud incorrect .....	B ....	Require replacement of stud.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

(1) - Some manufacturers require replacement of all studs on that wheel if two or more studs or nuts on the same wheel are broken or missing.

(2) - Only required if removing wheel.

## WHEEL SPEED SENSORS

See SPEED SENSORS (ELECTRONIC WHEEL AND VEHICLE) .

## WIRING HARNESSES AND CONNECTORS

### WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Insulation damaged, conductors exposed .....	A ..	Require repair or replacement.
Insulation damaged, conductors not exposed ..	1 .....	Suggest replacement.
Open .....	A ..	Require repair or replacement.
Protective shield (conduit) melted .....	2 .....	(1) Suggest repair or replacement.
Protective shield (conduit) missing .....	2 ..	Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A ..	Require repair or replacement.
Routed incorrectly .....	B .....	Require repair.
Secured incorrectly .....	B .....	Require repair.
Shorted .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Transmission connector leaking .....	.. .....	See TRANSMISSION ASSEMBLY.
Voltage drop out of specification .....	A ..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

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## YOKES AND SLIP YOKES

### YOKE AND SLIP YOKE INSPECTION

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Condition	Code	Procedure
Bearing cap bore distorted .....	A	.. Require repair or replacement.
Bent .....	A	..... Require replacement.
Bolt holes elongated ....	A	.. Require repair or replacement.
Bushing or seal surface worn, affecting performance .....	A	.. Require repair or replacement.
Leaking through soft yoke plug .....	A	... Require repair or replacement of soft yoke plug.
Retainer strap bent .....	A	..... Require replacement of retainer strap.
Slip yoke broken .....	A	..... Require replacement.
Splines worn, affecting performance .....	A	..... Require replacement.
Splines worn close to the end of their useful life .....	1	..... Suggest replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
U-bolt damaged, affecting performance .....	A	..... Require replacement of U-bolts.
Yoke damaged, affecting performance .....	A	.. Require repair or replacement.

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# **E - THEORY/OPERATION - 2.5L & 4.0L**

## **1993 Jeep Cherokee**

1993 ENGINE PERFORMANCE  
Chrysler Corp. Theory & Operation

Jeep; Cherokee, Grand Cherokee, Wrangler

### **INTRODUCTION**

This article covers basic description and operation of engine performance-related systems and components. Read this article before diagnosing vehicles or systems with which you are not completely familiar.

### **COMPUTERIZED ENGINE CONTROLS**

#### **POWERTRAIN CONTROL MODULE (PCM)**

The Powertrain Control Module (PCM) is a dual microprocessor that receives various signals from engine sensors and provides the necessary signals to control engine sub-systems. The PCM has a voltage converter that converts battery voltage to regulated 5-volt or 8-volt outputs. The regulated 5-volt output is used to power Manifold Absolute Pressure (MAP) sensor, Throttle Position Sensor (TPS) and logic circuits. The regulated 8-volt output is used to power crankshaft position sensor and camshaft position sensor in distributor.

The ignition and fuel injection systems are controlled by the PCM. Based on present engine operating conditions, the PCM is programmed to provide a precise amount of fuel and the correct ignition timing to meet existing engine speed and load requirements.

The PCM adjusts ignition timing based on inputs it receives from camshaft position sensor, MAP sensor, coolant temperature sensor, throttle position sensor, vehicle speed sensor, transmission gear selection (automatic transmissions only) and brake switch.

The PCM adjusts idle speed based on inputs it receives from throttle position sensor, vehicle speed sensor, transmission gear selection (automatic transmissions only), A/C clutch switch and brake switch.

The PCM also controls the speed (cruise) control system and alternator charge rate by controlling the alternator field.

**NOTE:** Components are grouped into 2 categories. The first category covers INPUT DEVICES, which control or produce voltage signals that are monitored by the PCM. The second category covers OUTPUT SIGNALS, which are components controlled by the PCM.

#### **INPUT DEVICES**

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine the input device usage on a specific model, see appropriate wiring diagram in L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section. The available input signals include the following:

A/C Pressure Switch & Evaporator Switch

When A/C switch is in ON position and A/C low pressure switch and evaporator switch are closed, an A/C select signal is sent to PCM. If A/C low pressure switch or evaporator switch opens, the PCM will

not receive an A/C select signal.

When A/C function is selected (A/C switch on), the A/C request signal provides information to the PCM from the A/C temperature control thermostat (evaporator switch). This signal indicates evaporator temperature is in the proper range for A/C operation.

The A/C request signal is used by PCM to determine required Idle Air Control (IAC) motor position and to activate or deactivate A/C compressor clutch. When PCM receives an A/C request signal, it repositions the IAC motor to increase idle speed. The increased idle speed compensates for additional engine load caused by engagement of A/C compressor.

On 4.0L, whenever A/C compressor clutch is energized, PCM also energizes the radiator (cooling) fan relay. This occurs regardless on engine coolant temperature.

#### Alternator Output

The PCM keeps charging system voltage at 13.5-14.8 volts. Charging system voltage will be adjusted by PCM based on battery temperature sensor, located within PCM housing. The voltage determined by PCM as final goal for charging system is called "control" voltage. The control voltage will be used to determine alternator field control and to detect if charging system is operating properly.

If sensed voltage is lower than "control" voltage, PCM will alter duty cycle and ground alternator (rotor) field for a longer period of time and create a higher alternator output which should raise sensed voltage level. If sensed voltage is higher than "control" voltage, PCM will alter duty cycle and lower alternator output which should lower sensed voltage level.

#### Battery Voltage Signal

The PCM uses battery voltage level to regulate alternator field (rotor) duty cycle and alter fuel injector pulse width according to available voltage. If battery voltage drops, PCM will increase injector on time to compensate for the reduced fuel flow of injector caused by the lower voltage. This will permit injector to deliver proper amount of fuel to the engine.

#### Brake Switch

The brake switch is mounted on steering column support bracket, under instrument panel. The PCM uses the brake switch to determine when brakes are applied. When brakes are applied (brake switch on) and if PCM sees a TPS opening and a lower speed sensor rate, it recognizes a deceleration condition and opens up the Idle Air Control (IAC) motor. The brake switch signal will also disengage speed (cruise) control operation, if it was engaged.

#### Coolant Temperature Sensor

The coolant temperature sensor is mounted on top of engine, next to thermostat housing. It provides an analog signal to the PCM that is used to calculate injector pulse width and ignition timing when engine is cold. Input from the coolant temperature sensor will also affect Idle Air Control (IAC) motor position and spark advance operation.

#### Crankshaft Position Sensor

The Hall Effect type crankshaft position sensor is mounted on transaxle bellhousing. The sensor reads slots (4 per cylinder) on flywheel/flex plate. The signal generated provides engine speed and crankshaft position information to PCM. The PCM uses this information to determine proper fuel injection and ignition timing.

When a flywheel/flex plate slot passes the crankshaft position sensor magnet, output voltage of the Hall Effect sensor goes



high (5 volts). When the metal between the slots is aligned with sensor, output voltage goes low (.3 volts).

This high/low voltage signal is sent to PCM each time one of the slots passes the crankshaft position sensor. The PCM uses this information to determine when to energize the injectors for fuel delivery to the proper cylinders.

#### Ignition Circuit

When ignition switch is turned to the ON position, the PCM receives a signal that the ignition circuit has been activated. The PCM will start monitoring input signals.

#### Manifold Absolute Pressure (MAP) Sensor

The MAP sensor is mounted on engine compartment firewall. The MAP sensor is used by PCM to calibrate amount of air/fuel mixture supplied to the engine. This sensor measures manifold absolute pressure. Ambient barometric pressure is also measured when ignition switch is first turned on, during engine cranking, and at wide open throttle.

The MAP sensor transmits a low voltage signal (1.5-2.1 volts) at idle when manifold vacuum is high, and a higher voltage signal (3.9-4.8 volts) during open throttle when manifold vacuum is low.

Input voltage (from the PCM) to MAP sensor ranges from 4.8-5.1 volts. Adjustments made as a result of this input will usually affect injector pulse width, ignition timing, idle speed and upshift indicator light.

#### Manifold Air Temperature (MAT) Sensor

The MAT sensor is located on intake manifold, with sensor element extending into the air stream. The sensor measures the temperature of air entering the intake manifold. This sensor provides an analog voltage signal to PCM. This signal is used to compensate for changes in air density due to temperature.

The MAT sensor is a Negative Temperature Coefficient (NTC) thermistor-type sensor. Its internal resistance varies opposite with temperature. At cold temperatures, the resistance is high. As temperature increases, its resistance decreases.

#### Oxygen (O2) Sensor

The heated oxygen sensor detects amount of oxygen content of the exhaust gases and produces a voltage signal. PCM uses this signal to determine system output signals which control air/fuel mixture.

Variations in voltage signal from O2 sensor serve as air/fuel ratio indicators. When oxygen content is low (rich mixture), voltage signal will be approximately one volt. When oxygen content is high (lean mixture), voltage signal will be approximately 0.1 volt.

The O2 sensor contains a ceramic heater in the sensor housing. The heater operates on 12 volts. The heater is used in cold starts to help O2 sensor heat up quicker and to maintain the O2 sensor's Zirconia semiconductor at operating temperature.

In "closed loop" operation, PCM monitors O2 sensor input (along with other sensors) and adjusts the injector pulse width accordingly. During "open loop" operation (cold oxygen sensor), PCM ignores O2 sensor input and adjusts injector pulse width to a pre-programmed value based on other sensor inputs.

#### Park/Neutral Switch

On vehicles equipped with automatic transmission, a gear position indicator signal is sent to the PCM when gear selector lever has been moved to the Drive range. This signal comes from the park/neutral switch (neutral safety switch on AW-4 transmission) and allows the PCM to adjust idle speed, fuel injector pulse width, and ignition timing advance.

#### Power Steering Switch

On 2.5L with power steering, a power steering switch is used. The switch is located on pressure line, next to power steering pump.

The power steering switch sends a signal to PCM when system pressure rises to greater than 250-300 psi (17.6-21.1 kg/cm<sup>2</sup>) when engine RPM is low. The PCM, through IAC motor, will then increase idle speed to prevent engine stalling.

#### Serial Communications Interface Receive

The Serial Communications Interface (SCI) receive circuit is the serial data circuit that is used when diagnosing vehicle with Chrysler's Diagnostic Readout Box-II (DRB-II). The PCM receives data from the DRB-II through this SCI receive circuit.

#### Speed (Cruise) Control Switches

The speed (cruise) control switches provide 3 separate inputs to the PCM. The ON/OFF switch informs PCM that speed control system has been activated. The SET switch informs PCM that a set vehicle speed has been selected. The RESUME switch informs PCM that the previously selected set speed has been selected.

#### Start (Cranking) Signal

The start (cranking) signal from starter relay signals PCM when starter is engaged. When PCM determines starter is engaged, it begins to monitor inputs from crankshaft position sensor and camshaft position sensor.

The PCM uses these signals to determine spark timing and whether the first fuel injection should occur at cylinder No. 4 or 1 (4-cylinder) or cylinder No. 3 or 4 (6-cylinder). Once synchronization has been established, the PCM energizes the proper injector and provides the ignition output needed to start the engine.

#### Camshaft Position Sensor

The camshaft position sensor is located in distributor. This Hall Effect type sensor works in conjunction with engine speed signal of crankshaft position sensor providing PCM with inputs necessary to establish and maintain proper fuel injector firing order.

When leading edge of pulse ring enters the sync signal generator on the camshaft position sensor, the resulting change in the magnetic field causes a 5-volt reference signal to be induced. On 4-cylinder engines, this indicates to the PCM that piston No. 4 will be the next piston at Top Dead Center (TDC). On 6-cylinder engine, it indicates that piston No. 3 will be at TDC.

When trailing edge of pulse ring leaves the sync signal generator on the camshaft position sensor, the resulting collapse of the magnetic field causes reference signal to drop to zero volts. On 4-cylinder engines, this indicates that piston No. 1 will be the next piston at TDC. On 6-cylinder engine, it indicates that piston No. 4 will be at TDC.

#### Throttle Position Sensor (TPS)

The TPS is mounted on throttle body and monitors opening angle of throttle valve. It contains a potentiometer operated by the opening and closing of throttle plate. PCM uses TPS input signal to determine throttle position under all operating conditions and adjust fuel injector pulse width and ignition timing accordingly.

The PCM supplies a 5-volt reference signal to TPS. The TPS output voltage (input signal to PCM) represents throttle blade position. The TPS output voltage varies from one volt at minimum throttle opening (idle) to 4 volts at wide open throttle.

#### Vehicle Speed Sensor

The vehicle speed sensor is located on transaxle extension housing (2WD models) or on transfer case extension housing (4WD models). The PCM uses vehicle speed (distance) sensor to detect if vehicle is moving and at what speed it is moving.

The sensor is an 8-pole switch which provides a pulse or switching rate, proportional to vehicle speed, to the PCM. By comparing the number of pulses to time elapsed, the PCM determines vehicle speed and distance traveled.

The vehicle speed sensor generates 8 pulses per sensor revolution. This signal, along with a closed throttle signal from the TPS sensor, indicates a closed throttle deceleration to the PCM.

Under deceleration conditions, PCM adjusts the Idle Air Control (IAC) motor to maintain desired MAP value. During idle (vehicle stopped), the PCM adjusts the IAC motor to maintain a desired engine speed.

The vehicle speed (distance) sensor input is used to maintain speed (cruise) control operation and also as a reference for Service Reminder Indicator (SRI) light.

#### Vehicle Theft Alarm (Cherokee)

Vehicle theft alarm module provides a signal to PCM to enable it to start the engine. With theft alarm module activated, no signal through the communication bus will be sensed by the PCM and the engine will not start. The PCM controls ignition and fuel delivery to the engine.

## OUTPUT SIGNALS

NOTE: Vehicles are equipped with different combinations of computer-controlled components. Not all components listed below are used on every vehicle. For theory and operation on each output component, refer to the system indicated after component.

A/C Compressor Clutch Relay  
See MISCELLANEOUS CONTROLS.

Alternator Light  
See MISCELLANEOUS CONTROLS.

Automatic Shutdown Relay  
See FUEL DELIVERY.

Ballast Resistor  
See FUEL DELIVERY.

Ballast Resistor By-Pass Relay  
See FUEL DELIVERY.

Fuel Injectors  
See FUEL CONTROL.

Fuel Pump Relay  
See FUEL DELIVERY.

Idle Air Control (IAC) Motor  
See IDLE SPEED.

Ignition Coil  
See IGNITION SYSTEM.

Injection Timing  
See FUEL CONTROL.

Malfunction Indicator Light (MIL)  
See SELF-DIAGNOSTIC SYSTEM.

Radiator (Cooling) Fan Relay  
See MISCELLANEOUS CONTROLS.

Serial Communication Interface Transmit  
See MISCELLANEOUS CONTROLS.

Service Reminder Indicator (SRI)  
See EMISSION SYSTEMS.

Speed (Cruise) Control Solenoids  
See MISCELLANEOUS CONTROLS.

Upshift Indicator Light  
See MISCELLANEOUS CONTROLS.

## **FUEL SYSTEM**

### **FUEL DELIVERY**

#### Automatic Shutdown Relay

The Automatic Shutdown (ASD) relay is located in power distribution center near the battery or next to radiator coolant recovery bottle.

The ASD relay is used by the PCM to supply voltage to fuel pump, fuel injectors and ignition coil. The relay contacts are normally open.

Power is supplied to relay coil when the ignition switch is turned on. The PCM controls the ground circuit, which energizes the coil and closes the relay contacts.

The PCM will only ground the relay when ignition switch is in the RUN or START positions and activity is sensed through the crankshaft position sensor and the camshaft position sensor in the distributor. If the PCM senses the RPM signal has stopped, it will remove the ground from relay coil, which will cause the contacts to open and remove power from the circuit.

#### Ballast Resistor (Cherokee)

A ballast resistor, located between fuel pump relay and the fuel pump, is used to reduce voltage to the fuel pump. This reduces fuel pump noise during operation. Ballast resistor is mounted on fender panel, next to washer fluid reservoir.

When fuel pump relay is energized, voltage is supplied to fuel pump through the ballast resistor. During start and wide open throttle conditions, ballast resistor is by-passed and fuel pump receives its voltage from ballast resistor by-pass relay.

**NOTE:** Wrangler DOES NOT use a ballast resistor or ballast resistor by-pass relay in the fuel pump circuit. The PCM operates fuel pump through the fuel pump relay during all operating conditions.

#### Ballast Resistor By-Pass Relay (Cherokee)

A ballast resistor by-pass relay is located on a bracket next to power distribution center (next to coolant recovery bottle). By switching the ground circuit on or off, the PCM can control fuel pump (power) feed. The ballast resistor by-pass relay receives its voltage from fuel pump relay.

Normally, voltage is supplied to fuel pump through a ballast

resistor. At wide open throttle, fuel pump receives voltage through the ballast resistor by-pass relay, which speeds up fuel pump to compensate for higher fuel demand.

#### Fuel Pump (Electric)

All models are equipped with a gear/rotor type electric pump. Pump is driven by a permanent magnet, 12-volt electric motor. The in-tank pump is an integral part of the fuel gauge sending unit.

Fuel system pressure is maintained at about 31 psi (2.2 kg/cm<sup>2</sup>) when pump is operating and vacuum is applied to fuel pressure regulator. With no vacuum applied to fuel pressure regulator, fuel pressure should be 39-41 psi (2.7-2.9 kg/cm<sup>2</sup>) or higher. When fuel pump is not operating, fuel pressure is maintained at 19-39 psi (1.3-2.7 kg/cm<sup>2</sup>) by fuel pump outlet check valve and the fuel pressure regulator.

#### Fuel Pump Relay

On Cherokee, fuel pump relay is located in the power distribution center, next to coolant recovery bottle. On Wrangler and Grand Cherokee, the fuel pump relay is located in the power distribution center next to battery.

The feed side of the relay coil is powered by the ignition switch. The relay is energized by the PCM by grounding the other side of the relay coil. The relay contacts are normally open and will close when the PCM provides a ground path for the relay coil.

The fuel pump circuit is completed during cranking and whenever the engine is running. If the ignition switch is turned to the RUN position, the fuel pump will operate for 1-3 seconds and then shut off. If the PCM does not receive a crank or run signal, it deactivates the fuel pump by opening the relay coil ground circuit. The 1-3 second time limit is used to prevent unnecessary operation of the fuel pump once the system is pressurized. If the engine were running, the PCM would maintain the fuel pump relay coil ground allowing continuous operation of the fuel pump.

## FUEL CONTROL

#### Fuel Injectors

The fuel injectors are controlled electronically by the PCM. Because each injector is connected to 12 volts, the injector is energized when connected to ground through the PCM. The PCM also controls the amount of time the injector is energized (pulse width). Pulse width is based on various inputs and is calculated by the PCM. The fuel injectors are sequentially energized (in firing order) by the PCM.

With injector connected to a pressurized fuel supply, a fine mist will spray from the injector nozzle into the intake manifold. The injector uses an electromagnet and spring pressure to open or close the fuel metering plunger. When connected to battery voltage, the coil of wire in the injector becomes an electromagnet. The magnetic field generated will overcome spring pressure and raise the plunger off its seat. When the injector circuit is opened by the PCM, the magnetic field collapses and spring pressure forces the plunger against its seat.

Whenever an injector is opened, it will always spray a consistent amount of fuel for a given amount of pressure. Because pressure drop across the injector is fixed and the fuel flow rate constant, the only control variable is the amount of time injector is open. By controlling the time the injector is open (pulse width), the PCM can decrease pulse width for engine idle or it can increase pulse width at wide open throttle.

#### Injection Timing

All engines use a sequential port fuel injection system. This means that the injectors have a specific firing order and fuel injection is timed to piston movement. The spark plugs and injectors are fired in the same order: 1-3-4-2 on 2.5L and 1-5-3-6-2-4 on 4.0L.

In order for the PCM to fire the injectors in a specific order timed to crankshaft and piston movement, it has to establish a reference point. Establishing the reference point requires PCM inputs from the crankshaft position sensor and camshaft position sensor.

The crankshaft position sensor is located on transmission bellhousing and provides the PCM with crankshaft angle and speed. The PCM converts crankshaft speed into engine RPM and crankshaft angle into piston position.

On 2.5L engine, the slotted flywheel/drive plate, rotating past the sensor, contains 2 groups of 4 slots located 180 degrees apart. Each group of slots represents the position of 2 of the pistons. Pistons No. 1 and 4 approach TDC at the same time and use the same flywheel slot, while piston No. 3 is matched with piston No. 2.

On 4.0L engine, the slotted flywheel/drive plate, rotating past the sensor, contains 3 groups of 4 slots located 120 degrees apart. Each group of slots represents the position of 2 of the pistons. Pistons No. 1 and 6 approach TDC at the same time and use the same flywheel slot. Pistons No. 2 and 5 are matched, while piston No. 3 is matched with piston No. 4.

The PCM, through the crankshaft position sensor, knows that 2 pistons are approaching TDC and uses the sync signal generator on the camshaft position sensor to determine which injector/spark plug to fire. See Fig. 1.

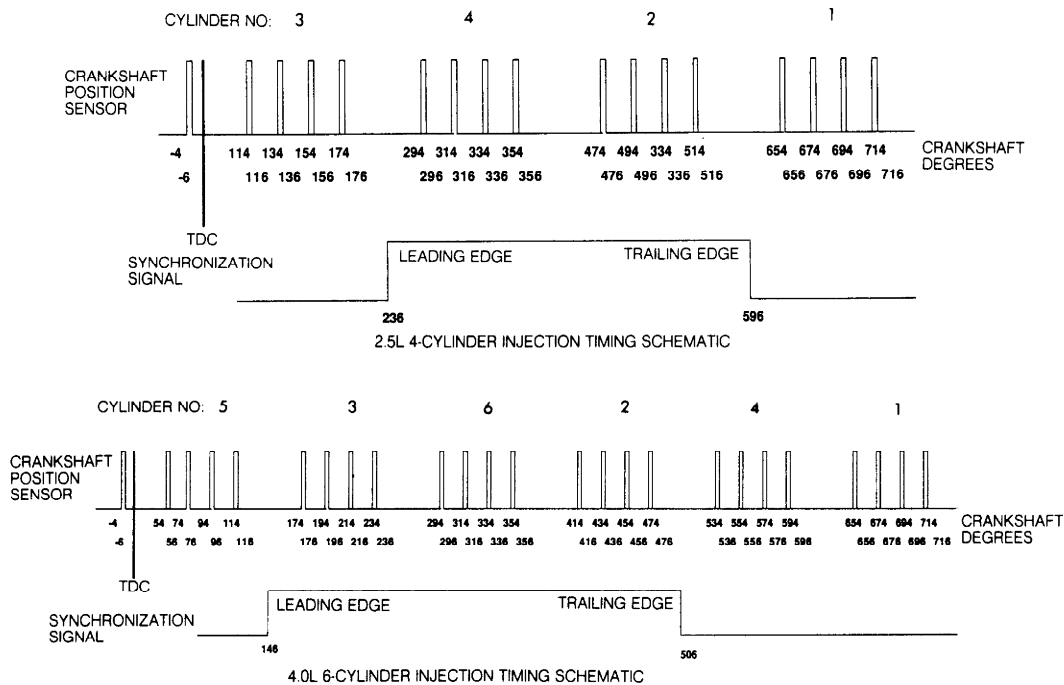


Fig. 1: Sequential Port Fuel Injection (SPFI) Timing

## IDLE SPEED

Idle Air Control (IAC) Motor

The IAC motor is mounted on throttle body and is used by the PCM to adjust engine idle speed. The throttle plate regulates off-idle

engine speed by controlling the amount of air allowed to enter the intake manifold and is mechanically operated by the accelerator cable.

The PCM and IAC motor adjust engine idle by regulating the size of an air by-pass passage that routes air past the closed throttle plate. The amount of air flowing through the by-pass circuit depends on engine operating conditions at idle.

When the engine is cold, the PCM increases engine speed by retracting the IAC motor pintle, thus allowing more air to enter the intake manifold. To maintain the proper air/fuel mixture, more fuel is also injected into the intake manifold. The increased air/fuel mixture, in turn, raises the engine idle speed. As the engine warms, the PCM will extend the motor pintle into the air passage to reduce the amount of air by-passing the throttle plate.

## **IGNITION SYSTEM**

### **POWERTRAIN CONTROL MODULE (PCM) CONTROLLED IGNITION SYSTEM**

All engines use a Powertrain Control Module (PCM) based ignition system. Base ignition timing is NOT adjustable with this system. The PCM controlled ignition system consists of coolant temperature sensor, crankshaft position sensor, distributor (includes rotor and camshaft position sensor), ignition coil, manifold absolute pressure sensor, PCM and throttle position sensor.

Coolant Temperature Sensor  
See INPUT DEVICES.

Crankshaft Position Sensor  
See INPUT DEVICES.

Distributor  
Distributor consists of cap, rotor, and camshaft position sensor. The distributor does not use centrifugal or vacuum advance mechanisms to advance ignition timing. Ignition timing advance is electronically controlled by the PCM. See CAMSHAFT POSITION SENSOR under INPUT DEVICES.

Ignition Coil  
The ignition coil is constructed of epoxy-embedded windings and is not oil filled. Battery voltage is supplied to the ignition coil positive terminal. The PCM receives inputs from the appropriate sensors. Based on these inputs, it then determines the proper ignition timing and interrupts the ignition coil ground signal to trigger secondary voltage of the ignition coil.

Manifold Absolute Pressure Sensor  
See INPUT DEVICES.

Manifold Air Temperature Sensor  
See INPUT DEVICES.

Powertrain Control Module (PCM)  
The PCM opens and closes the ignition coil ground circuit to adjust ignition timing according to engine operating conditions. The amount of electronic spark advance provided by the PCM is determined by coolant temperature sensor, crankshaft position sensor (engine RPM), manifold absolute pressure sensor and throttle position sensor inputs. See COMPUTERIZED ENGINE CONTROLS for additional information.

Throttle Position Sensor  
See INPUT DEVICES.

## **EMISSION SYSTEMS**

### **CRANKCASE VENTILATION (CCV) SYSTEM**

Engines on all models use a crankcase ventilation system. The CCV system performs the same function as a conventional PCV system, but does not use a vacuum controlled valve. On 2.5L engine, a fitting on the driver's side of the cylinder head cover contains a metered orifice that is connected to manifold vacuum. On 4.0L engine, a molded vacuum tube connects manifold vacuum to the top of the cylinder head cover. The molded vacuum tube contains a fixed, calibrated orifice that meters the amount of crankcase vapors drawn out of the engine.

On both engines, a fresh air supply hose from the air cleaner is connected to the cylinder head cover. When the engine is running, fresh air enters the engine and mixes with crankcase vapors. Manifold vacuum then draws the crankcase vapors/air mixture through the fixed orifice and into the engine by intake manifold vacuum.

### **SERVICE REMINDER INDICATOR (SRI) LIGHT**

The Service Reminder Indicator (SRI) light on instrument cluster indicates to vehicle owner components of the vehicle's emission system are scheduled for service or replacement.

The service reminder indicator function is built into the PCM. The PCM reads vehicle speed (distance) sensor and stores mileage information in a resettable memory. When the PCM sees the appropriate mileage has accumulated, about 82,500 miles (133,000 kilometers), it turns on the SRI light.

The SRI light must be turned off and the PCM reset by using Chrysler's Diagnostic Readout Box-II (DRB-II). If the PCM has been replaced, the current SRI mileage must be installed into the replacement PCM to maintain correct SRI light function. This procedure can only be accomplished by using the DRB-II diagnostic tester.

### **EVAPORATIVE EMISSION SYSTEM**

This system stores fuel vapors from fuel tank, preventing vapors from reaching the atmosphere. As fuel evaporates inside fuel tank, vapors are routed inside vent hoses to evaporative canister, where they are stored until engine is started.

The evaporative canister is equipped with a purge shutoff switch that controls canister purge operation. The switch is open when manifold vacuum is applied to it. The air cleaner contains a venturi as a purge line vacuum source. The effect of the venturi increases the speed of the intake air flowing by the slots in the venturi wall, creating a low pressure area around the slots. When the purge shutoff switch is open, vapors from the canister are drawn through slots and into the airstream flowing through the venturi. The vapors then pass through the intake manifold and into the engine combustion chambers.

#### **Evaporative Canister**

Evaporative canister is filled with granules of an activated carbon mixture. Fuel vapors entering the canister are absorbed by the granules. The evaporative canister has one inlet connected to the pressure relief/rollover valves of the fuel tank through hoses and tubes.

#### **Pressure Relief/Rollover Valve**

Fuel tanks are equipped with a pressure relief/rollover valve. The dual-function valve relieves fuel tank pressure and prevent fuel flow through fuel tank vent hoses in the event of a vehicle



rollover. The valve consists of a plunger, spring, orifice and guide plate. The valve is normally open, allowing fuel vapors to vent to the canister where they are stored.

If bottom of plunger is contacted by sloshing fuel in fuel tank, the plunger seats in the guide plate, preventing liquid fuel from reaching the evaporative canister. In a vehicle rollover, the valve is inverted. This forces the plunger against the guide plate and fuel is prevented from flowing through the valve orifice and into fuel tank vent tube.

## **SELF-DIAGNOSTIC SYSTEM**

### **MALFUNCTION INDICATOR LIGHT (MIL)**

NOTE: Malfunction Indicator Light (MIL) may also be referred to as CHECK ENGINE light.

The Malfunction Indicator Light (MIL) alerts driver if the PCM has recorded a system or sensor malfunction. MIL light will come on if vehicle goes into a "limp-in" mode. The MIL can also be used to display fault codes. By cycling the ignition on, off, on, off and on within 5 seconds, the PCM will display the fault codes in a series of flashes representing numbers. For additional information, see appropriate G - TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

## **MISCELLANEOUS CONTROLS**

NOTE: Although not considered true engine performance-related systems, some controlled devices may affect driveability if they malfunction.

### **A/C COMPRESSOR CLUTCH RELAY**

The PCM controls the A/C compressor clutch through a relay. This allows the PCM to receive an A/C select signal when driver moves mode lever into A/C position. The PCM also receives a request signal from the A/C temperature control thermostat (evaporator switch).

The PCM then adjusts idle speed using the IAC motor. Only then can the PCM activate the A/C compressor clutch through the A/C compressor clutch relay. The increased idle speed will compensate for the additional load caused by the A/C compressor.

On 4.0L engine, whenever the A/C compressor clutch is energized, the PCM also energizes the radiator (cooling) fan relay. This occurs regardless of engine coolant temperature.

### **ALTERNATOR LIGHT**

The alternator (charging indicator) light on the standard (base) instrument cluster will come on if the PCM senses a low charging condition or an overcharging condition. Once PCM compensates for the accessory electrical load, alternator light should go out.

### **RADIATOR COOLING FAN RELAY**

Cherokee 4.0L

An electric radiator cooling fan is used on models with A/C or heavy duty cooling. Normal operation of the radiator cooling fan is controlled by the PCM through the coolant sensor input. Cooling fan will also operate whenever A/C compressor clutch is activated, regardless of temperature.

When engine coolant temperature reaches 217°F (103°C), PCM supplies radiator cooling fan relay with a ground path which closes the radiator cooling fan relay contacts and allows battery voltage from the ignition switch to reach radiator cooling fan motor.

## **SERIAL COMMUNICATIONS INTERFACE TRANSMIT**

The Serial Communications Interface (SCI) transmit circuit is the serial data circuit that is used when diagnosing vehicle with Chrysler's Diagnostic Readout Box-II (DRB-II). The PCM transmits data to the DRB-II through this SCI transmit circuit.

## **SPEED (CRUISE) CONTROL SOLENOIDS**

The PCM controls the vacuum, vent, and dump solenoids when operating the cruise control system. When the SET button is pushed, the PCM sees voltage on terminal No. 48. When button is released, the voltage signal is removed and the PCM locks in a set speed for the system. The set speed becomes the target for the cruise control system to maintain. The cruise control system will not permit speeds higher than 85 MPH to be set.

The PCM energizes the vacuum solenoids located in the cruise control servo assembly to open the throttle to maintain the set speed. To increase set speed, the PCM grounds the vacuum solenoid through terminal No. 33 of the PCM. The solenoid receives battery voltage with ignition on and as long as the brakes are off. The vacuum solenoid is spring loaded to block vacuum from getting into the servo diaphragm. When energized, vacuum solenoid is pulled open, allowing vacuum to enter servo diaphragm and open throttle.

At the same time vacuum solenoid is being commanded to open the throttle, the PCM must supply a ground to the vent solenoid. The vent solenoid is spring loaded so that when it is not energized, it bleeds vacuum from the servo chamber. The vent solenoid receives battery voltage with ignition switch on and as long as the brakes are off. When the PCM supplies the vent solenoid with a ground, the solenoid blocks the leakage of vacuum from the servo chamber. To increase throttle opening, the PCM grounds the vacuum solenoid. To reduce throttle opening, the PCM grounds the vent solenoid.

Anytime the brakes are applied, the brake switch will interrupt power supply to the dump solenoid which causes it to vent vacuum as the vent and vacuum solenoids return to their relaxed (non-energized) positions by opening their ground circuits. The dump solenoid is reset when the brakes are released but the PCM will only reactivate the vacuum and vent solenoids when the RESUME switch is pushed.

## **UPSHIFT INDICATOR LIGHT**

Vehicles equipped with a manual transmission have an upshift light located in the instrument cluster. The upshift light is controlled by the PCM and will illuminate the light to inform the driver when to shift to the next higher gear for best fuel economy. The PCM determines which gear should be used by observing and remembering RPM and manifold absolute pressure values. A high gear switch is NOT used in the transmission.

# **\* ELECTRICAL SYSTEM UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

Electrical System Motorist Assurance Program  
Standards For Automotive Repair

All Makes and Models

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

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## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW OF MOTORIST ASSURANCE PROGRAM**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper,

manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published.

In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

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January 1999

## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

#### Reasons to Require Repair or Replacement

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

#### Reasons to Suggest Repair or Replacement

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

## ELECTRICAL SYSTEMS

### SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

NOTE: When working on electrical systems, if a potentially hazardous condition is observed, require repair or replacement of affected components prior to performing further work.

### ACTUATOR MOTORS (SOLENOIDS) (ELECTRIC)

#### ACTUATOR MOTOR (SOLENOIDS) (ELECTRIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.

Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Inoperative .....	A	.....	(2) Require replacement.
Linkage bent, affecting performance .....	A	...	Require repair or replacement of linkage.
Linkage bent, not affecting performance ..	2	...	Suggest repair or replacement of linkage.
Linkage binding, affecting performance .....	A	...	Require repair or replacement of linkage.
Linkage binding, not affecting performance ..	1	...	Suggest repair or replacement of linkage.
Linkage broken .....	A	...	Require repair or replacement of linkage.
Linkage loose, affecting performance .....	A	...	Require repair or replacement of linkage.
Linkage loose, not affecting performance ..	1	...	Suggest repair or replacement of linkage.
Linkage missing .....	C	.....	Require replacement.
Linkage noisy .....	2	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	1	.....	(1) Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	1	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	..	Suggest repair or replacement.
Out of adjustment .....	B	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.

## ACTUATOR MOTORS (VACUUM)

### ACTUATOR MOTOR (VACUUM) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of



				hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.	
Connector broken .....	A	..	Require repair or replacement.	
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.	
Connector melted .....	A	.....	(1) Require repair or replacement.	
Connector missing .....	C	.....	Require replacement.	
Inoperative .....	A	.....	(2) Require replacement.	
Leaking (vacuum) .....	A	..	Require repair or replacement.	
Linkage bent, affecting performance ..	A	...	Require repair or replacement of linkage.	
Linkage bent, not affecting performance ..	2	...	Suggest repair or replacement of linkage.	
Linkage binding, affecting performance ..	A	...	Require repair or replacement of linkage.	
Linkage binding, not affecting performance ..	1	..	Suggest repair or replacement of linkage.	
Linkage broken .....	A	...	Require repair or replacement of linkage.	
Linkage loose, affecting performance .....	A	...	Require repair or replacement of linkage.	
Linkage loose, not affecting performance ..	1	...	Suggest repair or replacement of linkage.	
Linkage missing .....	C	.....	Require replacement.	
Linkage noisy .....	2	..	Suggest repair or replacement.	
Missing .....	C	.....	Require replacement.	
Noisy .....	2	..	Suggest repair or replacement.	
Out of adjustment .....	A	..	Require repair or replacement.	
(1) - Determine cause and correct prior to repair or replacement of part.				
(2) - Inoperative includes intermittent operation or out of OEM specification.				

## AIR BAGS

For all air bag components and conditions, refer to vehicle manufacturer's specifications for diagnosis and parts replacement.

## ALTERNATORS AND GENERATORS

**NOTE:** If components have been added that increase vehicle electrical load requirement (for example, sound systems, air conditioning, alarm systems, etc.), charging system output must meet the increased demand.

### ALTERNATOR AND GENERATOR INSPECTION

Condition	Code	Procedure
Alternator output meets OEM specification but is insufficient for add-on		

electrical load .....	2	...	Suggest upgrade of alternator or removal of excess electrical load.
Alternator's rated output is below OEM specification .....	B	.....	Require replacement.
Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware non-functioning .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Diode inoperative .....	A	.....	(2) Require repair or replacement.
Housing broken, affecting performance .....	A	..	Require repair or replacement.
Housing broken, not affecting performance ..	..	.....	No service suggested or required.
Housing cracked, affecting performance .....	A	..	Require repair or replacement.
Housing cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Inoperative .....	A	.....	(2) Require repair or replacement.
Noisy .....	2	..	Suggest repair or replacement.
Pulley incorrect .....	B	.....	Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Terminal resistance (voltage drop) out of specification .....	A	..	Require repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Voltage drop out of specification .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification.

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## AMPLIFIERS

See  
RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS.

## ANTENNAS

### ANTENNA INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Broken .....	A	..... Require replacement.
Bent .....	2	.. Suggest repair or replacement.
Binding .....	2	.. Suggest repair or replacement.
Connector broken .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	A	..... (2) Require replacement.
Insulation damaged, conductors exposed .....	A	.. Require repair or replacement.
Insulation damaged, conductors not exposed ..	1	..... Suggest replacement.
Missing .....	C	..... Require replacement.
Motor runs continuously ..	A	..... Require or replacement.
Power antenna noisy .....	2	.. Suggest repair or replacement.
Sticking .....	2	.. Suggest repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or  
replacement of part.

(2) - Inoperative includes intermittent operation or out of  
specification.

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## BATTERIES

Proper operation of any electrical system or component can be  
affected by battery condition. The battery(ies) must meet or exceed

minimum specification for vehicle as equipped and test to that specific battery's CCA.

#### Definition of Terms

- \* Battery Performance Testing  
Testing that determines whether or not a battery meets both vehicle OEM and battery manufacturer's specifications.
- \* Cold Cranking Amp (CCA) Rating  
The number of amperes a new, fully charged battery at 0° F (-17.8° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).
- \* Cranking Amps (CA)  
The number of amperes a new, fully charged battery, typically at 32° F (0° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).
- \* OEM Cranking Amps  
The minimum CCA required by the original vehicle manufacturer for a specific vehicle.

#### BATTERY INSPECTION

Condition	Code	Procedure
Battery frozen .....	..	(1) Further inspection required.
Case leaking .....	A	Require replacement.
Casing swollen .....	A	(2) Further inspection required.
Circuit open internally .	A	Require replacement.
Electrolyte contamination .....	A	(2) Further inspection required.
Electrolyte discoloration .....	A	(2) Further inspection required.
Fails to accept and hold charge .....	A	(3) Require replacement.
Fluid level low .....	B	(4) Further inspection required.
Out of performance specification for battery .....	B	(5) Require replacement.
Out of specification for application .....	B	(5) Require replacement.
Post (top or side) burned, affecting performance ..	A	(6) Require repair or replacement.
Post (top or side) burned, not affecting performance .....	2	(6) Suggest repair or replacement.
Post (top or side) corroded, affecting performance .....	A	Require repair.
Post (top or side) corroded, not affecting performance .....	2	Suggest repair.

Post (top or side) loose .....	A .....	Require replacement.
Post (top or side) melted, affecting performance ..	A .....	(6) Require repair or replacement.
Post (top or side) melted, not affecting performance .....	2 .....	(6) Suggest repair or replacement.
Specific gravity low ....	B .....	(7) Further inspection required.
State of charge low .....	A .....	(7) Further inspection required.
Top dirty .....	2 .....	Suggest cleaning battery.
Top wet .....	A ...	(8) Require cleaning battery. Further inspection required.
Vent cap loose .....	A ...	Require repair or replacement of vent cap.
Vent cap missing .....	C .....	Require replacement of vent cap.

- (1) - DO NOT attempt to charge a frozen battery. Allow battery to warm thoroughly and then performance-test. If battery fails performance test, require replacement.
- (2) - No service suggested or required unless the battery fails performance test, in which case, require replacement.
- (3) - This phrase refers to a battery that fails to either accept and/or retain a charge using appropriate times listed in the Battery Charging Guide of the BCI Service Manual, battery charger operating manual, or battery manufacturer's specifications.
- (4) - Determine cause of low fluid level. Refill to proper level(s) with water (distilled water preferred). Recharge battery and performance-test. If battery does not meet specifications, require replacement. If battery is sealed type (non-removable filler caps), require replacement.
- (5) - The battery may meet battery manufacturer's specifications but test below the minimum specification defined by the vehicle's OEM for that vehicle.
- (6) - Determine cause and correct prior to repair or replacement of part.
- (7) - Recharge and test to manufacturer's specifications. If battery fails performance test, require replacement.
- (8) - Check fluid level and adjust to manufacturer's specification. Suggest checking charging system for proper operation.

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## BATTERY CABLES

See BATTERY CABLES, WIRES AND CONNECTORS.

## BATTERY CABLES, WIRES AND CONNECTORS

### BATTERY CABLE, WIRE AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware		

missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Insulation damaged, conductors exposed .....	A	.....	(2) Require repair or replacement.
Insulation damaged, conductors not exposed .	1	.....	Suggest replacement.
Open .....	A	..	Require repair or replacement.
Protective shield (conduit) melted .....	2	.....	(1) Suggest repair or replacement.
Protective shield (conduit) missing .....	2	..	Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A	..	Require repair or replacement.
Routed incorrectly .....	B	.....	Require repair.
Secured incorrectly .....	B	.....	Require repair.
Shorted .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Voltage drop out of specification .....	A	..	Require repair or replacement.
(1) - Determine cause and correct prior to repair or replacement of part.			
(2) - Exposed conductor at replacement (aftermarket) terminal end does not require repair or replacement.			

## BATTERY HOLD DOWN HARDWARE

See BATTERY TRAYS AND HOLD DOWN HARDWARE.

## BATTERY TRAYS AND HOLD DOWN HARDWARE

### BATTERY TRAY AND HOLD DOWN HARDWARE INSPECTION

Condition	Code	Procedure
Battery improperly secured .....	2	..... Suggest repair.
Bent, affecting performance .....	A	.. Require repair or replacement.
Bent, not affecting		

performance .. .. .	..	.....	No service suggested or required.
Broken, affecting performance .....	A	..	Require repair or replacement.
Broken, not affecting performance .....	..	.....	No service suggested or required.
Corroded, affecting performance .....	A	..	Require repair or replacement.
Corroded, not affecting performance .....	2	..	Suggest repair or replacement.
Cracked, affecting performance .....	A	..	Require repair or replacement.
Cracked, not affecting performance .....	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Water drain clogged .....	A	.....	Require repair.

## BATTERY WIRES

See BATTERY CABLES, WIRES AND CONNECTORS.

## BELTS

### BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B	..... (1) Further inspection required.
Cracked .....	1	..... Suggest replacement.
Frayed .....	1	..... Suggest replacement.
Missing .....	C	..... Require replacement.
Noisy .....	2	..... (2) Further inspection required.
Plies separated .....	A	..... Require replacement.
Tension out of specification .....	B	..... Require adjustment or replacement.
Worn beyond adjustment range .....	B	..... Require replacement.
Worn so it contacts bottom of pulley .....	A	..... Require replacement.

(1) - Determine cause of incorrect alignment and require repair.

(2) - Determine cause of noise and suggest repair.

## BULB SOCKETS

### BULB SOCKET INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of

				hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.	
Bulb seized in socket ...	A	..	Require repair or replacement.	
Burned, affecting performance .....	A	.....	(1) Require repair or replacement.	
Burned, not affecting performance .....	2	.....	(1) Suggest repair or replacement.	
Broken .....	A	..	Require repair or replacement.	
Connector broken .....	A	..	Require repair or replacement.	
Connector missing .....	C	.....	Require replacement.	
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.	
Connector melted .....	A	.....	(1) Require repair or replacement.	
Corroded, affecting performance .....	A	..	Require repair or replacement.	
Corroded, not affecting performance .....	2	..	Suggest repair or replacement.	
Leaking .....	A	..	Require repair or replacement.	
Melted .....	A	.....	(2) Require replacement.	
Shorted .....	A	..	Require repair or replacement.	
Terminal broken .....	A	..	Require repair or replacement.	
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.	
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance .....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.	
(1) - Determine cause and correct prior to repair or replacement of socket.				
(2) - Determine cause and correct prior to replacement of part.				

## BULBS, SEALED BEAMS AND LEDS

NOTE: Does not include soldered-in components.

### BULB, SEALED BEAM AND LED INSPECTION

Condition	Code	Procedure
Adjustment out of specification .....	B	.. Require repair or replacement.
Application incorrect ...	B	..... (1) Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not		



functioning .....	A	...	Require repair or replacement of hardware.
Base burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Base burned, not affecting performance .....	2	.....	(2) Suggest repair or replacement.
Base corroded, affecting performance .....	A	..	Require repair or replacement.
Base corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Base leaking .....	A	..	Require repair or replacement.
Base loose, affecting performance .....	B	..	Require repair or replacement.
Base loose, not affecting performance .....	1	..	Suggest repair or replacement.
Base melted .....	A	.....	(2) Require replacement.
Bracket bent, affecting performance .....	A	..	Require repair or replacement.
Bracket bent, not affecting performance ..	..	.....	No service suggested or required.
Bracket broken, affecting performance .....	A	.....	Require replacement.
Bracket broken, not affecting performance ..	..	.....	No service suggested or required.
Bracket corroded, affecting performance ..	A	..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A	..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket loose, affecting performance .....	A	..	Require repair or replacement.
Bracket loose, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket missing .....	C	.....	Require replacement.
Burned out .....	A	.....	Require replacement.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(2) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Corroded, affecting performance .....	A	..	Require repair or replacement.
Corroded, not affecting performance .....	2	..	Suggest repair or replacement.
Cracked .....	A	.....	Require replacement.
Intermittent .....	A	.....	Require replacement.
Lamp base melted .....	A	.....	(2) Require replacement.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Seized in socket .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Terminal burned, not			

affecting performance ..	2	.....	(2) Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - Application incorrect includes wrong bulb coating or color.

(2) - Determine cause and correct prior to repair or replacement of part.

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## CD PLAYERS

See TAPE PLAYERS AND CD PLAYERS.

## CIGARETTE LIGHTER ASSEMBLIES

### CIGARETTE LIGHTER ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Inoperative .....	A	..... (1) Require repair or replacement.
Loose .....	A	.. Require repair or replacement.
Missing .....	2	..... Suggest replacement.
Sticking .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

(2) - Determine cause and correct prior to repair or replacement of part.

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## CIRCUIT BREAKERS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

## CLUTCH SWITCHES

See SWITCHES.

## CONNECTORS

See WIRING HARNESSES AND CONNECTORS.

## CONTROL MODULES

### CONTROL MODULE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Code set (if applicable) .....	A	..... (1) Further inspection required.
Connector broken .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (2) Require repair or replacement.
Connector missing .....	A	..... Require repair.
Contaminated .....	A	..... (3) Require repair or replacement.
Inoperative .....	B	..... (4) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.

Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
- (2) - Determine cause and correct prior to repair or replacement of part.
- (3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (4) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## CRUISE CONTROL BRAKE SWITCHES

See SWITCHES.

## CRUISE CONTROL CABLES

See CRUISE CONTROL LINKAGES AND CABLES.

## CRUISE CONTROL CLUTCH SWITCHES

See SWITCHES.

## CRUISE CONTROL LINKAGES AND CABLES

### CRUISE CONTROL LINKAGE AND CABLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bent .....	A ..	Require repair or replacement.
Binding .....	A ..	Require repair or replacement.
Bracket bent, affecting performance .....	A ..	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A .....	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A ..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 ..	Suggest repair or replacement.

Bracket cracked, affecting performance .....	A	..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket loose, affecting performance .....	A	..	Require repair or replacement.
Bracket loose, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket missing .....	C	.....	Require replacement.
Broken .....	A	.....	Require replacement.
Cracked .....	A	..	Require repair or replacement.
Disconnected .....	A	..	Require repair or replacement.
Kinked .....	A	..	Require repair or replacement.
Melted .....	A	.....	(1) Require repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	..	Suggest repair or replacement.
Out of adjustment .....	B	.....	(2) Require repair or replacement.
Routed incorrectly .....	2	.....	Suggest repair.
Seized .....	A	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

## CRUISE CONTROL RESERVOIRS

See CRUISE CONTROL VACUUM HOSES, TUBES AND RESERVOIRS.

## CRUISE CONTROL TUBES

See CRUISE CONTROL VACUUM HOSES, TUBES AND RESERVOIRS.

## CRUISE CONTROL VACUUM DUMP RELEASE VALVES

### CRUISE CONTROL VACUUM DUMP RELEASE VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Broken .....	A	.. Require repair or replacement.
Inoperative .....	A	..... (1) Require replacement.
Leaking .....	2	..... Suggest replacement.
Out of adjustment .....	B	..... (2) Further inspection required.

(1) - Inoperative includes intermittent operation or out of OEM specification.

(2) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

## CRUISE CONTROL VACUUM HOSES, TUBES AND RESERVOIRS

### CRUISE CONTROL VACUUM HOSE, TUBE AND RESERVOIR INSPECTION

Condition	Code	Procedure
Leaking .....	A ..	Require repair or replacement.
Melted .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Oil-soaked (spongy) .....	1 .....	Suggest replacement.
Restricted .....	A ..	Require repair or replacement.
Surface cracks (dry-rotted) .....	1 .....	Suggest replacement.

## CRUISE CONTROL VEHICLE SPEED SENSORS

### CRUISE CONTROL VEHICLE SPEED SENSOR INSPECTION

Condition	Code	Procedure
Air gap incorrect .....	B .....	(1) Require adjustment to vehicle manufacturer's specifications.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Broken .....	A .....	Require replacement.
Housing cracked .....	A .....	Require replacement.
Internal resistance does not meet specifications .....	B .....	(2) Require replacement.
Lead routing incorrect ..	B ..	Require rerouting according to vehicle manufacturer's specifications.
Loose .....	B .....	(3) Require adjustment to vehicle manufacturer's specifications.
Missing .....	C .....	Require replacement.
Output signal incorrect ..	B .....	(2) Require repair or replacement.
Surface contaminated ....	2 ..	Suggest cleaning; identify and correct source.
Tip bent .....	B .....	Require replacement.
Tip broken .....	B .....	Require replacement.
Tip missing .....	B .....	Require replacement.
Wire lead burned .....	A .....	Require replacement.
Wire lead conductors exposed .....	B .....	Require replacement.
Wire lead corroded .....	A .....	Require replacement.
Wire lead open .....	A .....	Require replacement.
Wire lead shorted .....	A .....	Require replacement.

(1) - If a sensor is not adjustable, further inspection is required to identify and correct cause.

(2) - Component failure may be caused by water intrusion into the wiring harness. Always check insulation for damage

- and wiring for excessive resistance.
- (3) - Some integral bearing assemblies with sensors may require replacement.

## DEFOGGERS

See  
HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS) .

## DEFROSTERS

See  
HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS) .

## DELAYS

### DELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Binding, affecting performance .....	A ..	Require repair or replacement.
Binding, not affecting performance .....	2 ..	Suggest repair or replacement.
Broken .....	A ..	Require repair or replacement.
Burned, affecting performance .....	A .....	(1) Require repair or replacement.
Burned, not affecting performance .....	2 .....	(1) Suggest repair or replacement.
Cracked, affecting performance .....	A ..	Require repair or replacement.
Cracked, not affecting performance .....	1 ..	Suggest repair or replacement.
Inoperative .....	A .....	(2) Require repair or replacement.
Melted, affecting performance .....	A .....	(1) Require repair or replacement.
Melted, not affecting performance .....	2 .....	(1) Suggest repair or replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not		

affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of OEM specification.

## DIMMERS

### DIMMER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Binding, affecting performance .....	A ..	Require repair or replacement.
Binding, not affecting performance .....	2 ..	Suggest repair or replacement.
Broken .....	A ..	Require repair or replacement.
Burned, affecting performance .....	A .....	(1) Require repair or replacement.
Burned, not affecting performance .....	2 .....	(1) Suggest repair or replacement.
Cracked, affecting performance .....	A ..	Require repair or replacement.
Cracked, not affecting performance .....	1 ..	Suggest repair or replacement.
Inoperative .....	A .....	(2) Require repair or replacement.
Melted, affecting performance .....	A .....	(1) Require repair or replacement.
Melted, not affecting performance .....	2 .....	(1) Suggest repair or replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.



Terminal loose, not  
affecting performance .. 1 .. Suggest repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of OEM specification.

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## ELECTRIC HEATERS

See  
HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS) .

## EQUALIZERS

See  
RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS .

## FUSE BLOCKS

See FUSE BOXES AND BLOCKS .

## FUSE BOXES AND BLOCKS

### FUSE BOX AND BLOCK INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ..	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Broken, affecting performance .....	A .....	Require replacement.
Broken, not affecting performance .....	.. ..	No service suggested or required.
Burned, affecting performance .....	A .....	(1) Require repair or replacement.
Burned, not affecting performance .....	2 .....	(1) Suggest repair or replacement.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Cover missing .....	C ..	Require replacement of cover.
Cracked, affecting performance .....	A ..	Require repair or replacement.
Cracked, not affecting performance .....	1 ..	Suggest repair or replacement.
Melted, affecting performance .....	A .....	(1) Require replacement.

Melted, not affecting performance .....	2	.....	(1) Suggest replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

## FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS

### FUSE, FUSIBLE LINK AND CIRCUIT BREAKER INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Blown .....	A	..... (1) Require replacement.
Corroded, affecting performance .....	A	.. Require repair or replacement.
Corroded, not affecting performance .....	2	.. Suggest repair or replacement.
Cracked, affecting performance .....	A	.. Require repair or replacement.
Cracked, not affecting performance .....	1	.. Suggest repair or replacement.
Inoperative .....	A	..... (2) Require replacement.
Insulation damaged, conductors exposed .....	A	.. Require repair or replacement.
Insulation damaged, conductors not exposed ..	1	..... Suggest replacement.
Missing .....	C	..... Require replacement.
Routed incorrectly .....	B	..... Require repair.
Secured incorrectly .....	B	..... Require repair.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation.

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## FUSIBLE LINKS

See FUSES, FUSIBLE LINKS AND CIRCUIT BREAKERS.

## GAUGES

NOTE: Includes odometers, speedometers and tachometers (except cable-driven).

### GAUGE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Leaking .....	A .....	Require replacement.
Lens broken .....	A .....	(2) Require repair or replacement.
Lens cloudy .....	2 .....	(2) Suggest repair or replacement.
Lens missing .....	C .....	(2) Require repair or replacement.
Malfunctioning .....	A .....	(3) Require repair or replacement.
Mechanical head noisy ...	2 ..	Suggest repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
  - (2) - If lens is available as a separate part, require replacement of lens only.
  - (3) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.
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## GENERATORS

See ALTERNATORS AND GENERATORS.

## GROUND CABLES AND STRAPS

### GROUND CABLE AND STRAP INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Corroded, affecting performance .....	A ..	Require repair or replacement.
Corroded, not affecting performance .....	2 ..	Suggest repair or replacement.
Insulation damaged, exposing conductors ....	2 .....	Suggest replacement.
Loose .....	A .....	Require repair.
Missing .....	C .....	Require replacement.
Open .....	A ..	Require repair or replacement.
Resistance high .....	A ..	Require repair or replacement.
Terminal resistance (voltage drop) is out of specification .....	B ..	Require repair or replacement.
Voltage drop out of specification .....	B ..	Require repair or replacement.

## GROUND STRAPS

See GROUND CABLES AND STRAPS.

## HEADLIGHT ADJUSTERS

### HEADLIGHT ADJUSTER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bent, preventing adjustment .....	A ..	Require repair or replacement.
Broken .....	A ..	Require repair or replacement.
Indicator broken .....	A .....	Require replacement.
Indicator missing .....	C .....	Require replacement.
Missing .....	C .....	Require replacement of

				adjusters.
Seized .....	A	..	Require repair or replacement.	
Threads damaged .....	A	..	Require repair or replacement.	
Threads stripped (threads missing) .....	A	.....	Require replacement.	

## HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS)

### HEATING ELEMENT (DEFROSTER, DEFOGGER, ELECTRIC HEATER AND SEAT) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	A	..... (2) Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Wire lead burned .....	A	.. Require repair or replacement.
Wire lead conductors exposed .....	B	.. Require repair or replacement.
Wire lead open .....	A	.. Require repair or replacement.
Wire lead shorted .....	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

## HORNS AND SIRENS

### HORN AND SIREN INSPECTION

Condition	Code	Procedure
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Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Inoperative .....	A	.....	(2) Require repair or replacement.
Missing .....	C	.....	Require replacement.
Out of adjustment .....	B	.....	Require adjustment.
Sound quality poor .....	A	..	Require repair or replacement. Further inspection required.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or  
replacement of part.

(2) - Inoperative includes intermittent operation.

## IGNITION SWITCHES

See SWITCHES.

## INDICATOR LIGHTS

### INDICATOR LIGHT INSPECTION

Condition	Code	Procedure
Does not come on during bulb check .....	..	..... (1) Further inspection required.
Fails to function properly during test mode .....	..	..... (1) Further inspection required.
On constantly .....	..	..... (1) Further inspection required.

On intermittently ..... .. (1) Further inspection  
required.

(1) - See service manual for further information.

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## KEYLESS ENTRY KEYPADS AND TRANSMITTERS

### KEYLESS ENTRY KEYPAD AND TRANSMITTER INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Malfunctioning .....	A .....	(2) Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Wire lead burned .....	A ..	Require repair or replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or  
replacement of part.

(2) - Malfunctioning includes inoperative, intermittent  
operation, or failure to perform all functions.

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## KEYLESS ENTRY TRANSMITTERS

See KEYLESS ENTRY KEYPADS AND TRANSMITTERS.

## LEDS

See BULBS, SEALED BEAMS AND LEDS.

## LENSES

### LENSE INSPECTION

Condition	Code	Procedure
Adjustment out of specification .....	B .....	Require repair.
Application incorrect ...	A .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Broken, affecting performance .....	A .....	Require replacement.
Broken, not affecting performance.....	.. .....	No service suggested or required.
Cracked .....	A .....	Require replacement.
Discolored .....	A .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Melted, affecting performance .....	A .....	Require replacement.
Melted, not affecting performance .....	2 .....	Suggest replacement.
Missing .....	C .....	Require replacement.

## MICROPHONES

See SPEAKERS AND MICROPHONES.

## MIRRORS (ELECTROCHROMATIC AND HEATED)

### MIRROR (ELECTROCHROMATIC AND HEATED) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Broken .....	A ..	Require repair or replacement.
Connector broken .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Cracked .....	A .....	Require replacement.
Inoperative .....	A .....	(2) Require replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or



					replacement.
Terminal burned, not affecting performance	..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance	..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance	..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance	.....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance	..	1	..	Suggest repair or replacement.	
Wire lead burned	.....	A	..	Require repair or replacement.	
Wire lead conductors exposed	.....	B	..	Require repair or replacement.	
Wire lead open	.....	A	..	Require repair or replacement.	
Wire lead shorted	.....	A	..	Require repair or replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation.

## MOTORS

### MOTOR INSPECTION

Condition		Code		Procedure
Amperage draw out of specification	.....	A	..	Require repair or replacement.
Attaching hardware broken	.....	A	...	Require repair or replacement of hardware.
Attaching hardware missing	.....	C	.....	Require replacement of hardware.
Attaching hardware not functioning	.....	A	...	Require repair or replacement of hardware.
Bracket bent	.....	A	..	Require repair or replacement.
Bracket broken	.....	A	..	Require repair or replacement.
Bracket cracked	.....	A	..	Require repair or replacement.
Bracket holes elongated, affecting performance	..	A	..	Require repair or replacement.
Bracket holes elongated, not affecting performance	.....	..	.....	No service suggested or required.
Bracket missing	.....	C	.....	Require replacement.
Connector broken	.....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking	.....	A	..	Require repair or replacement.
Connector melted	.....	A	.....	(1) Require repair or replacement.
Connector missing	.....	C	.....	Require replacement.
Drive mechanism damaged, affecting performance	..	A	.....	(2) Require repair or replacement.
Drive mechanism damaged, not affecting performance	.....	2	.....	(2) Suggest repair or replacement.
Fails to disengage	.....	A	..	Require repair or replacement.

Housing broken, affecting performance .....	2	..	Suggest repair or replacement.
Housing broken, not affecting performance ..	..	..	..... No service suggested or required.
Housing cracked, affecting performance .....	A	..	Require repair or replacement.
Housing cracked, not affecting performance ..	1	..	Suggest repair or replacement.
Inoperative .....	A	.....	(3) Require repair or replacement.
Linkage bent, affecting performance .....	A	...	Require repair or replacement of linkage.
Linkage bent, not affecting performance ..	..	..	..... No service suggested or required.
Linkage binding, affecting performance .....	A	...	Require repair or replacement of linkage.
Linkage binding, not affecting performance ..	2	...	Suggest repair or replacement of linkage.
Linkage broken .....	A	...	Require repair or replacement of linkage.
Linkage loose, affecting performance .....	A	...	Require repair or replacement of linkage.
Linkage loose, not affecting performance ..	1	...	Suggest repair or replacement of linkage.
Linkage missing .....	C	.....	Require replacement.
Linkage noisy .....	2	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	..	Suggest repair or replacement.
Out of adjustment .....	B	.....	(4) Further inspection required.
Resistance out of specification .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
 (2) - Further inspection required to determine cause.  
 (3) - Inoperative includes intermittent operation.

- (4) - Follow OEM recommended adjustment procedures. Repair or replace if out of specification.

## NEUTRAL SAFETY SWITCHES

See SWITCHES.

## ODOMETERS

See GAUGES.

## ODOMETERS, SPEEDOMETERS AND TACHOMETERS (CABLE-DRIVEN)

### ODOMETER, SPEEDOMETER AND TACHOMETER (CABLE-DRIVEN) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Drive cable broken .....	A .....	Require replacement.
Drive cable noisy .....	2 ..	Suggest repair or replacement.
Inoperative .....	A .....	(2) Further inspection required.
Leaking .....	A .....	Require replacement.
Lens broken .....	A .....	(3) Require repair or replacement.
Lens cloudy .....	2 .....	(3) Suggest repair or replacement.
Lens missing .....	C .....	(3) Require repair or replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.

- (2) - If lens is available as a separate part, require

replacement of lens only.

- (3) - Includes inoperative, intermittent operation, failure to perform all functions, out of OEM specification, or out of range.

## PULLEYS

### PULLEY INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B ..	Require repair or replacement.
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bent .....	A .....	Require replacement.
Cracked .....	A .....	Require replacement.
Loose .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Pulley damaged, affecting belt life .....	A .....	Require replacement.

## RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS

### RECEIVER, AMPLIFIER, EQUALIZER AND SUB-WOOFER VOLUME CONTROL INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Malfunctioning .....	A .....	(2) Require repair or replacement.
Missing .....	C .....	Require replacement.
Sound quality poor .....	A .....	(3) Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.

Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Malfunctioning includes inoperative, intermittent operation, or failure to perform all functions.
- (3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical interference.

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## RELAY BOXES

### RELAY BOX INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Broken, affecting performance .....	A	... Require replacement.
Broken, not affecting performance .....	..	... No service suggested or required.
Burned, affecting performance .....	A	... (1) Require repair or replacement.
Burned, not affecting performance .....	2	... (1) Suggest repair or replacement.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	... (1) Require repair or replacement.
Connector missing .....	C	... Require replacement.
Cover missing .....	C	... Require replacement of cover.
Cracked, affecting performance .....	A	.. Require repair or replacement.
Cracked, not affecting performance .....	1	.. Suggest repair or replacement.
Melted, affecting performance .....	A	... (1) Require replacement.
Melted, not affecting		

performance .....	2	.....	(1) Suggest replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

## RELAYS

### RELAY INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Housing broken .....	A	..... Require replacement.
Housing cracked .....	2	..... Suggest replacement.
Inoperative .....	A	..... (1) Require replacement.
Missing .....	C	..... Require replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

(2) - Determine cause and correct prior to repair or replacement of part.

## SEALED BEAMS

See BULBS, SEALED BEAMS AND LEDS.

## SEAT HEATERS

See

HEATING ELEMENTS (DEFROSTERS, DEFOGGERS, ELECTRIC HEATERS AND SEATS) .

## SECURITY ALARM SENSORS

### SECURITY ALARM SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	B .....	(2) Require repair or replacement. Further inspection required.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

## SIRENS

See HORNS AND SIRENS.

## SOLENOIDS

See ACTUATOR MOTORS (SOLENOIDS) (ELECTRIC) .

NOTE: For starter solenoids that are integral to the starter assembly, see STARTERS.

NOTE: For starter relays, see RELAYS.

## SPEAKERS AND MICROPHONES

### SPEAKER AND MICROPHONE INSPECTION

Condition	Code	Procedure
Application incorrect ...	A .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	B .....	(2) Require repair or replacement. Further inspection required.
Membrane torn .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Polarity reversed .....	A .....	Require repair.
Sound quality poor .....	A .....	(3) Require repair or replacement. Further inspection required.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

(3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical



interference.

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## SPEEDOMETER AND TACHOMETER LINKAGES AND CABLES

### SPEEDOMETER AND TACHOMETER LINKAGE AND CABLE INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bent .....	A ..	Require repair or replacement.
Binding .....	A ..	Require repair or replacement.
Bracket bent, affecting performance .....	A ..	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A .....	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A ..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A ..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket loose, affecting performance .....	A ..	Require repair or replacement.
Bracket loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket missing .....	C .....	Require replacement.
Broken .....	A .....	Require replacement.
Cracked .....	A ..	Require repair or replacement.
Disconnected .....	A ..	Require repair or replacement.
Kinked .....	A ..	Require repair or replacement.
Melted .....	A .....	(1) Require repair or replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Routed incorrectly .....	2 .....	Suggest repair.
Seized .....	A ..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or  
replacement of part.

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## SPEEDOMETER CABLES

See SPEEDOMETER AND TACHOMETER LINKAGES AND CABLES.

## SPEEDOMETERS

See GAUGES.

## STARTERS

NOTE: To prevent misdiagnosis, care should be taken to eliminate the possibilities of mechanical problems or high resistance in power and/or ground circuits.

### STARTER INSPECTION

Condition	Code	Procedure
Amperage draw does not meet OEM specifications	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A .....	(1) Require repair or replacement of hardware.
Bracket bent, affecting performance .....	A ..	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A .....	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A ..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A ..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket holes elongated, affecting performance ..	A ..	Require repair or replacement.
Bracket holes elongated, not affecting performance) .....	.. ..	No service suggested or required.
Bracket loose, affecting performance .....	A ..	Require repair or replacement.
Bracket loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Bracket missing .....	C .....	Require replacement.
Drive gear damaged, affecting performance ..	A .....	(2) Require repair or replacement.
Drive gear damaged, not affecting performance ..	2 .....	(2) Suggest repair or replacement.
Fails to disengage .....	A ..	Require repair or replacement.
Housing broken, affecting performance .....	2 ..	Require repair or replacement.
Housing broken, not		

affecting performance .. ..	.....	No service suggested or required.
Housing cracked, affecting performance .....	A	... Require repair or replacement.
Housing cracked, not affecting performance ..	2	.. Suggest repair or replacement.
Inoperative .....	A	..... (3) Require repair or replacement.
Noisy .....	2	.. Suggest repair or replacement.
Shimmed incorrectly .....	B	..... Require repair.
Starter shaft bushing missing .....	C	..... (4) Require replacement.
Starter shaft bushing worn, affecting performance .....	A	..... Require replacement.
Starter shaft bushing worn, not affecting performance .....	1	..... Suggest replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (5) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

- (1) - Inspect block or bell housing mounting surface.  
(2) - Further inspection required to determine cause. Require inspection of ring gear.  
(3) - Inoperative includes intermittent operation.  
(4) - Bushing may be in bell housing.  
(5) - Determine cause and correct prior to repair or replacement of part.

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## SUB-WOOFER VOLUME CONTROLS

See  
RECEIVERS, AMPLIFIERS, EQUALIZERS AND SUB-WOOFER VOLUME CONTROLS.

## SWITCHES

### SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Binding, affecting		

performance .....	A	..	Require repair or replacement.
Binding, not affecting performance .....	2	..	Suggest repair or replacement.
Broken .....	A	..	Require repair or replacement.
Burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Burned, not affecting performance .....	2	.....	(1) Suggest repair or replacement.
Cracked, affecting performance .....	A	..	Require repair or replacement.
Cracked, not affecting performance .....	1	..	Suggest repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Malfunctioning .....	A	.....	(2) Require repair or replacement.
Melted, affecting performance .....	A	.....	(1) Require repair or replacement.
Melted, not affecting performance .....	2	.....	(1) Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Out of adjustment .....	B	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Won't return .....	A	..	Require repair or replacement.
Worn .....	1	.....	Suggest replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Includes inoperative, intermittent operation, or failure to perform all functions.

## TACHOMETER CABLES

See SPEEDOMETER AND TACHOMETER LINKAGES AND CABLES.

## TACHOMETERS

See GAUGES.

## TAPE PLAYERS AND CD PLAYERS

### TAPE PLAYER AND CD PLAYER INSPECTION

Condition	Code	Procedure
Attaching hardware		

broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Malfunctioning .....	A	.....	(2) Require repair or replacement.
Missing .....	C	.....	Require replacement.
Skips .....	A	..	Require repair or replacement.
Sound quality poor .....	A	.....	(3) Require repair or replacement.
Speed incorrect .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Malfunctioning includes inoperative, intermittent operation, or failure to perform all functions.
- (3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical interference.

## TENSIONERS

### TENSIONER INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B	.. Require repair or replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement

				of hardware.
Bearings worn .....	1	.....	Suggest replacement.	
Belt tension incorrect ..	B	...	Require adjustment or repair.	
Cracked .....	2	.....	Suggest replacement.	
Missing .....	C	.....	Require replacement.	
Noisy .....	2	.....	Suggest replacement.	
Pulley damaged, affecting belt life .....	A	.....	Require replacement.	
Seized .....	A	..	Require repair or replacement.	

## TIMERS

### TIMER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Broken .....	A	.. Require repair or replacement.
Burned, affecting performance .....	A	..... (1) Require repair or replacement.
Burned, not affecting performance .....	2	..... (1) Suggest repair or replacement.
Cracked, affecting performance .....	A	.. Require repair or replacement.
Cracked, not affecting performance .....	1	.. Suggest repair or replacement.
Inoperative .....	A	..... (2) Require repair or replacement.
Melted, affecting performance .....	A	..... (1) Require repair or replacement.
Melted, not affecting performance .....	2	..... (1) Suggest repair or replacement.
Missing .....	C	..... Require replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

## TIRE PRESSURE SENSORS

### TIRE PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Inoperative .....	A .....	(1) Require repair or replacement.
Loose .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## TRANSCIEVERS

### TRANSCIEVER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Malfunctioning .....	A .....	(2) Require repair or replacement.
Missing .....	C .....	Require replacement.
Sound quality poor .....	A .....	(3) Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting		

performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead burned .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Malfunctioning includes inoperative, intermittent operation, or failure to perform all functions.
- (3) - Make sure poor sound quality is not caused by ignition/charging system or other forms of electrical interference.

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## TRANSDUCERS

### TRANSDUCER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Drive mechanism damaged, affecting performance ..	A	..... (2) Require repair or replacement.
Drive mechanism damaged, not affecting performance .....	2	..... (2) Suggest repair or replacement.
Inoperative .....	A	..... (3) Require repair or replacement.
Leaking (vacuum/fluid/air) .....	A	..... Require replacement.
Linkage bent, affecting performance .....	A	... Require repair or replacement of linkage.
Linkage bent, not affecting performance ..	..	..... No service suggested or required.
Linkage binding, affecting performance .....	A	... Require repair or replacement of linkage.
Linkage binding, not affecting performance ..	2	... Suggest repair or replacement of linkage.
Linkage broken .....	A	... Require repair or replacement



					of linkage.
Linkage loose, affecting performance .....	A	...	Require repair or replacement of linkage.		
Linkage loose, not affecting performance ..	1	...	Suggest repair or replacement of linkage.		
Linkage missing .....	C	.....	Require replacement.		
Linkage noisy .....	2	..	Suggest repair or replacement.		
Out of adjustment .....	B	.....	(4) Further inspection required.		
Terminal broken .....	A	..	Require repair or replacement.		
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.		
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.		
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.		
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.		
Terminal loose, affecting performance .....	B	..	Require repair or replacement.		
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.		

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Further inspection required to determine cause.
- (3) - Inoperative includes intermittent operation or out of specification.
- (4) - Follow OEM recommended adjustment procedures. Repair or replace if out of specification.

## VACUUM ACCUMULATORS (RESERVOIRS)

### VACUUM ACCUMULATOR (RESERVOIR) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Leaking .....	A	.. Require repair or replacement.

## VACUUM RESERVOIRS

See VACUUM ACCUMULATORS (RESERVOIRS) .

## VOLTAGE REGULATORS

### VOLTAGE REGULATOR INSPECTION

Condition	Code	Procedure
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Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Inoperative .....	A	.....	(2) Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - NOTE: Inoperative includes intermittent operation or out of OEM specification.

## WASHER FLUID LEVEL SENDERS

### WASHER FLUID LEVEL SENDER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Inoperative .....	A	..... (1) Require repair or replacement.
Leaking .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.

Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.  
(2) - Determine cause and correct prior to repair or replacement of part.

## WASHER PUMPS

### WASHER PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	A	..... (2) Require repair or replacement.
Leaking externally .....	A	.. Require repair or replacement.
Leaking internally .....	A	.. Require repair or replacement.
Noisy .....	2	.. Suggest repair or replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Wire lead conductors exposed .....	B	.. Require repair or replacement.

Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation.

## WIPER ARMS AND BLADES

NOTE: Windshield coatings or waxes can cause blades to not function as intended. Clean surface before making final judgment about blade replacement.

### WIPER ARM AND BLADE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Attaching socket stripped .....	A	..... Require replacement.
Bent .....	A	.. Require repair or replacement.
Loose .....	2	.. Suggest repair or replacement.
Missing .....	C	..... Require replacement.
Noisy .....	2	.. Suggest repair or replacement.
Size incorrect .....	2	..... Suggest replacement.
Tension insufficient ....	B	.. Require repair or replacement.
Torn .....	A	..... Require replacement.
Worn, affecting performance .....	A	..... Require replacement.
Worn, not affecting performance .....	1	..... Suggest replacement.

## WIPER BLADES

See WIPER ARMS AND BLADES.

## WIPER HOSES AND NOZZLES

### WIPER HOSE AND NOZZLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Blocked .....	A	.. Require repair or replacement.

Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Oil-soaked (spongy) .....	1	.....	Suggest replacement.
Spray pattern incorrect .	2	..	Suggest repair or replacement.
Surface cracks (dry-rotted) .....	1	.....	Suggest replacement.

## WIPER LINKAGES

### WIPER LINKAGE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Attaching stud stripped .	A	..... Require replacement.
Bent .....	A	.. Require repair or replacement.
Inoperative .....	A	..... (1) Require replacement.
Loose .....	2	.. Suggest repair or replacement.
Missing .....	C	..... Require replacement.
Noisy .....	2	.. Suggest repair or replacement.
Tension insufficient ....	B	.. Require repair or replacement.
Worn, affecting performance .....	A	..... Require replacement.
Worn, not affecting performance .....	1	..... Suggest replacement.

(1) - Inoperative includes intermittent operation.

## WIPER NOZZLES

See WIPER HOSES AND NOZZLES.

## WIPER PUMP RESERVOIRS

### WIPER PUMP RESERVOIR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Cap missing .....	C	..... Require replacement.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.

## WIRING HARNESSES AND CONNECTORS

### WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Insulation damaged, conductors exposed .....	A ..	Require repair or replacement.
Insulation damaged, conductors not exposed ..	1 .....	Suggest replacement.
Open .....	A ..	Require repair or replacement.
Protective shield (conduit) melted .....	2 .....	(1) Suggest repair or replacement.
Protective shield (conduit) missing .....	2 ..	Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A ..	Require repair or replacement.
Routed incorrectly .....	B .....	Require repair.
Secured incorrectly .....	B .....	Require repair.
Shorted .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Voltage drop out of specification .....	A ..	Require repair or replacement.
(1) - Determine cause and correct prior to repair or replacement of part.		

ELECTRICAL COMPONENT LOCATOR

1993 Jeep Cherokee

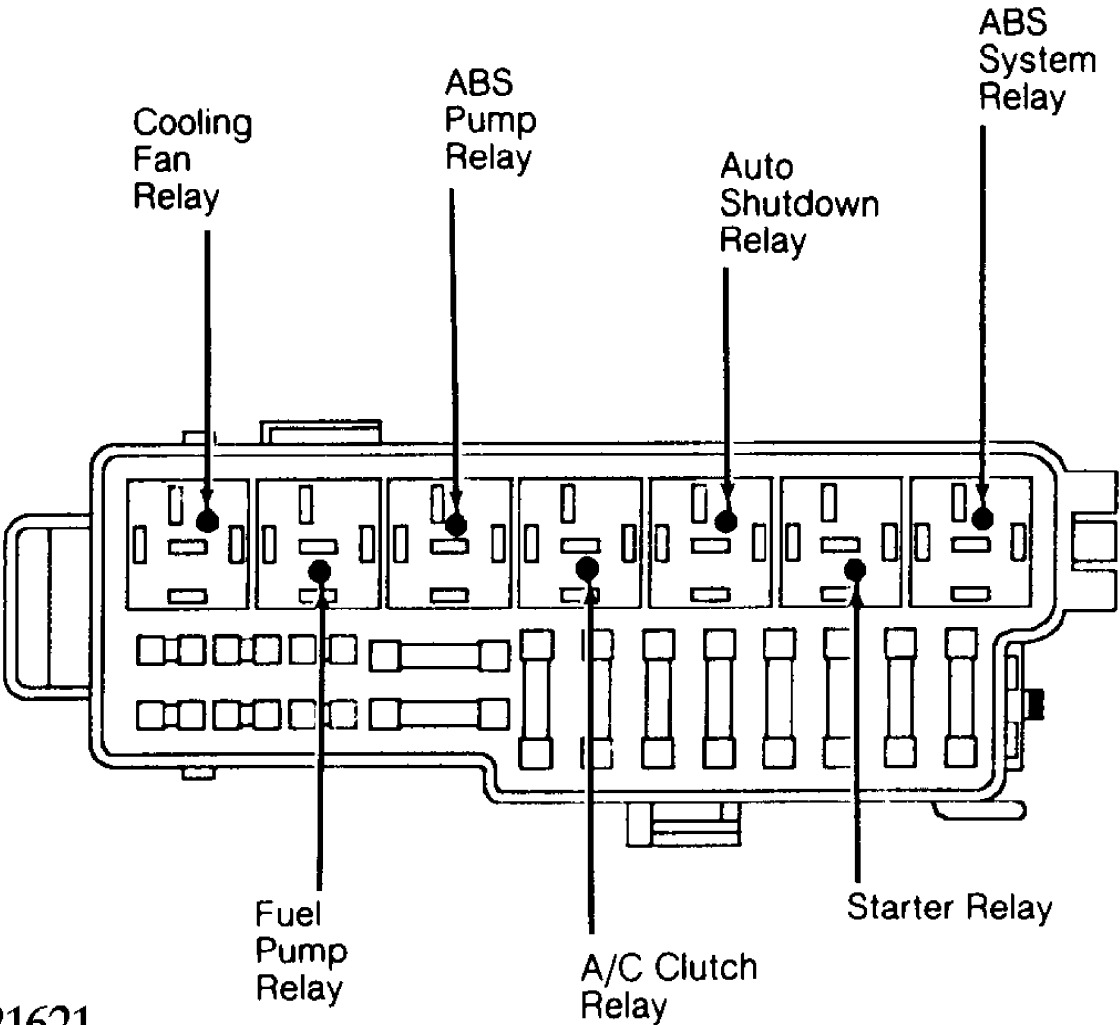
1993 ELECTRICAL COMPONENT LOCATIONS  
Jeep Electrical Components

Cherokee

BUZZERS, RELAYS & TIMERS

Component	Component Location
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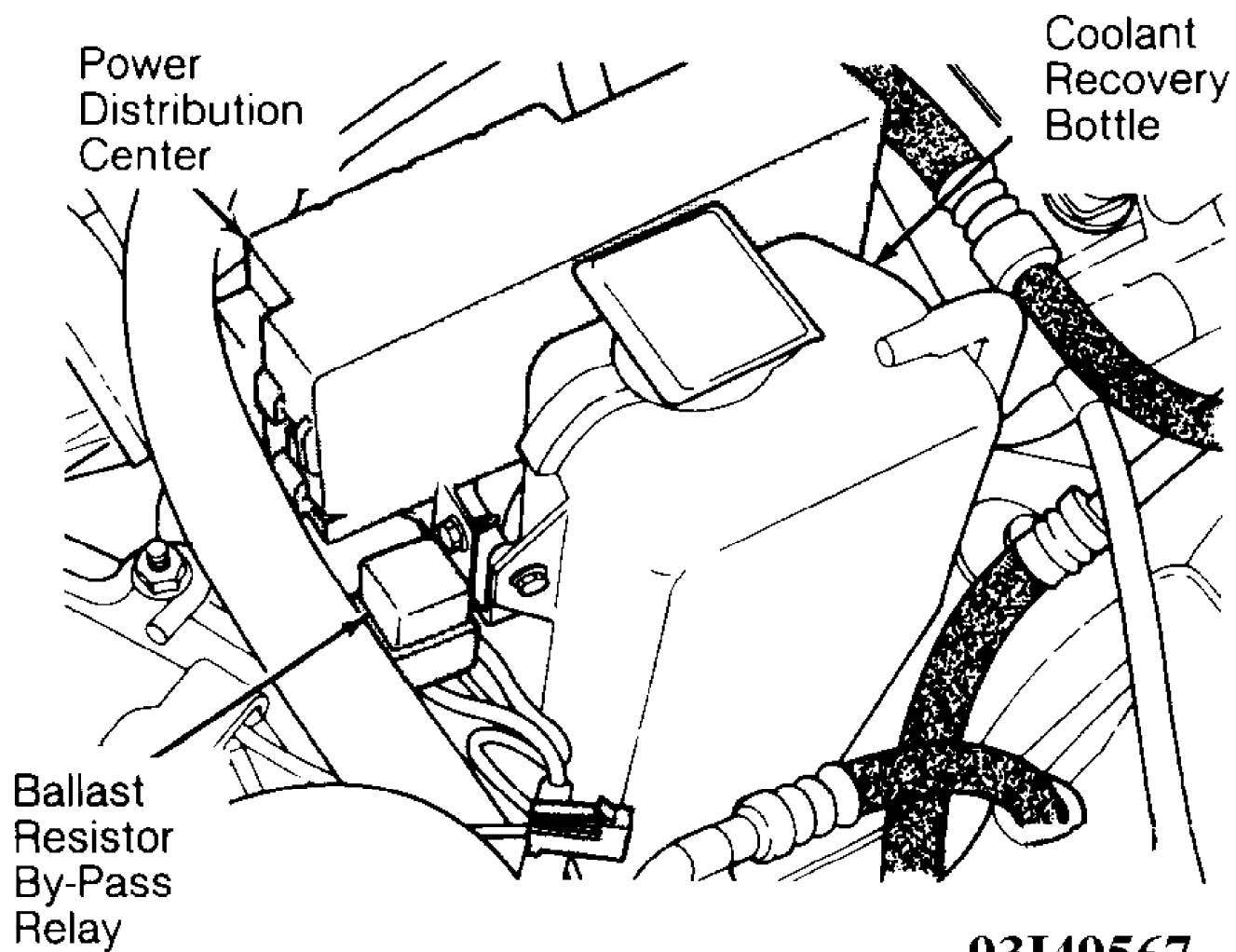
ABS Pump Relay



92F21621

POWER DISTRIBUTION CENTER

In power distribution center.

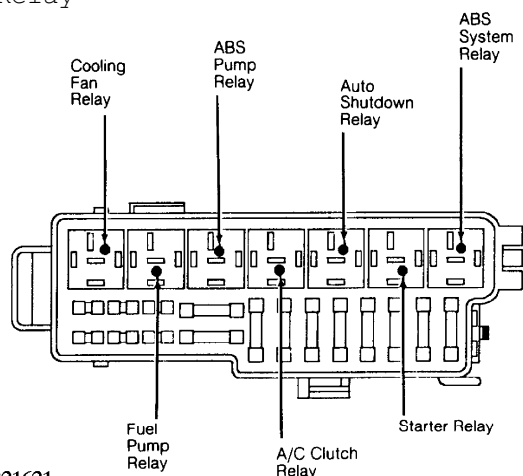


93I49567

Graphic No. 2

In power distribution center.

ABS System Relay



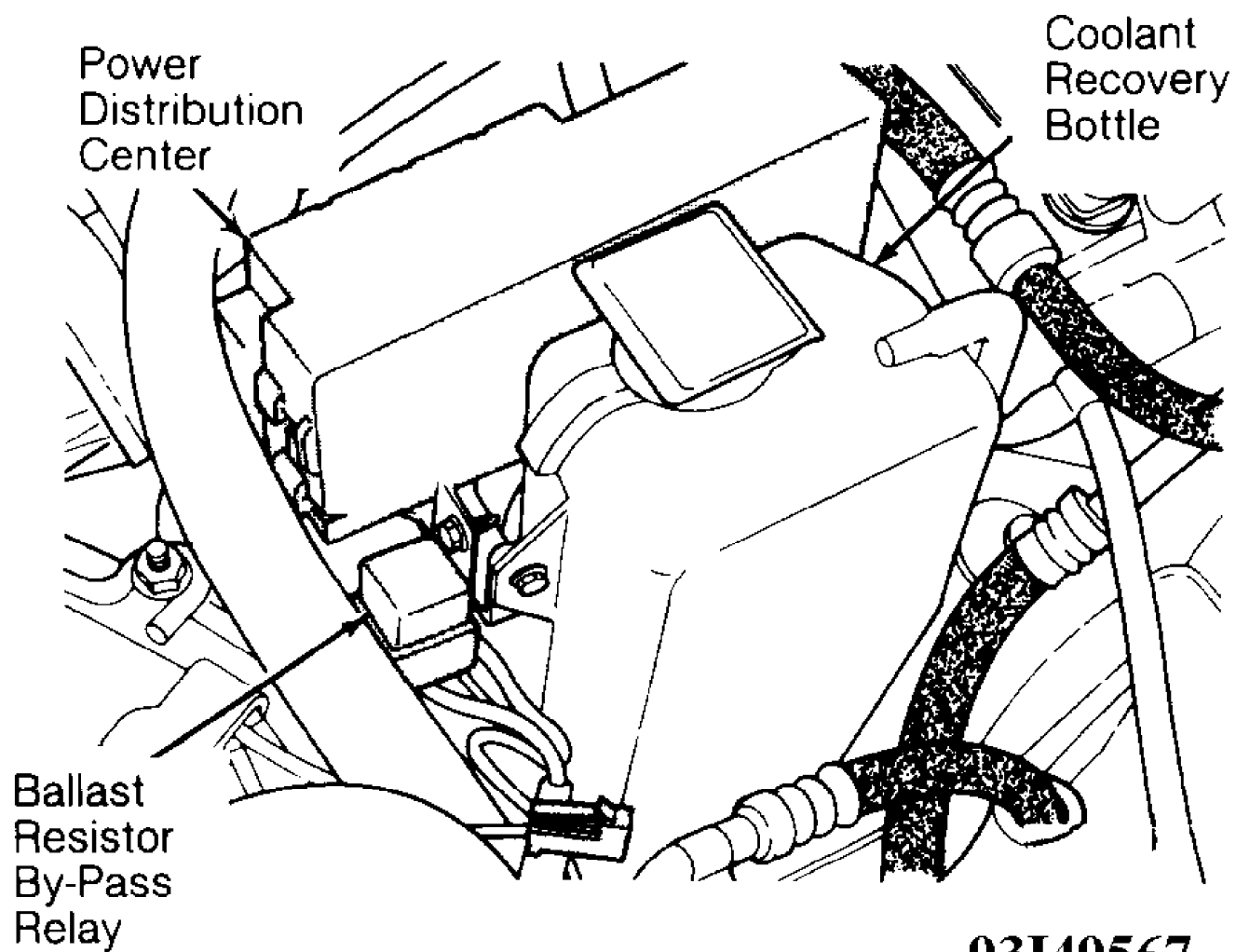
92F21621

**POWER DISTRIBUTION CENTER**

Graphic No. 1

In power distribution center.

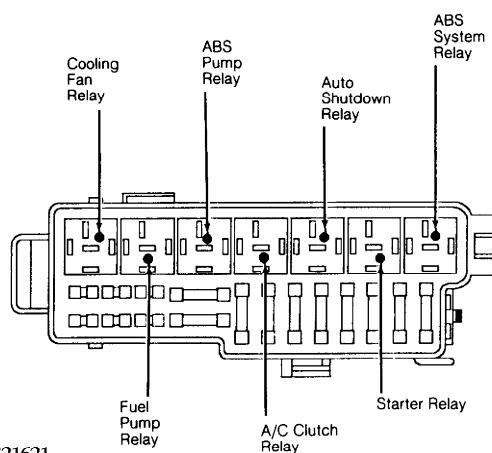




93I49567

Graphic No. 2

In power distribution center.

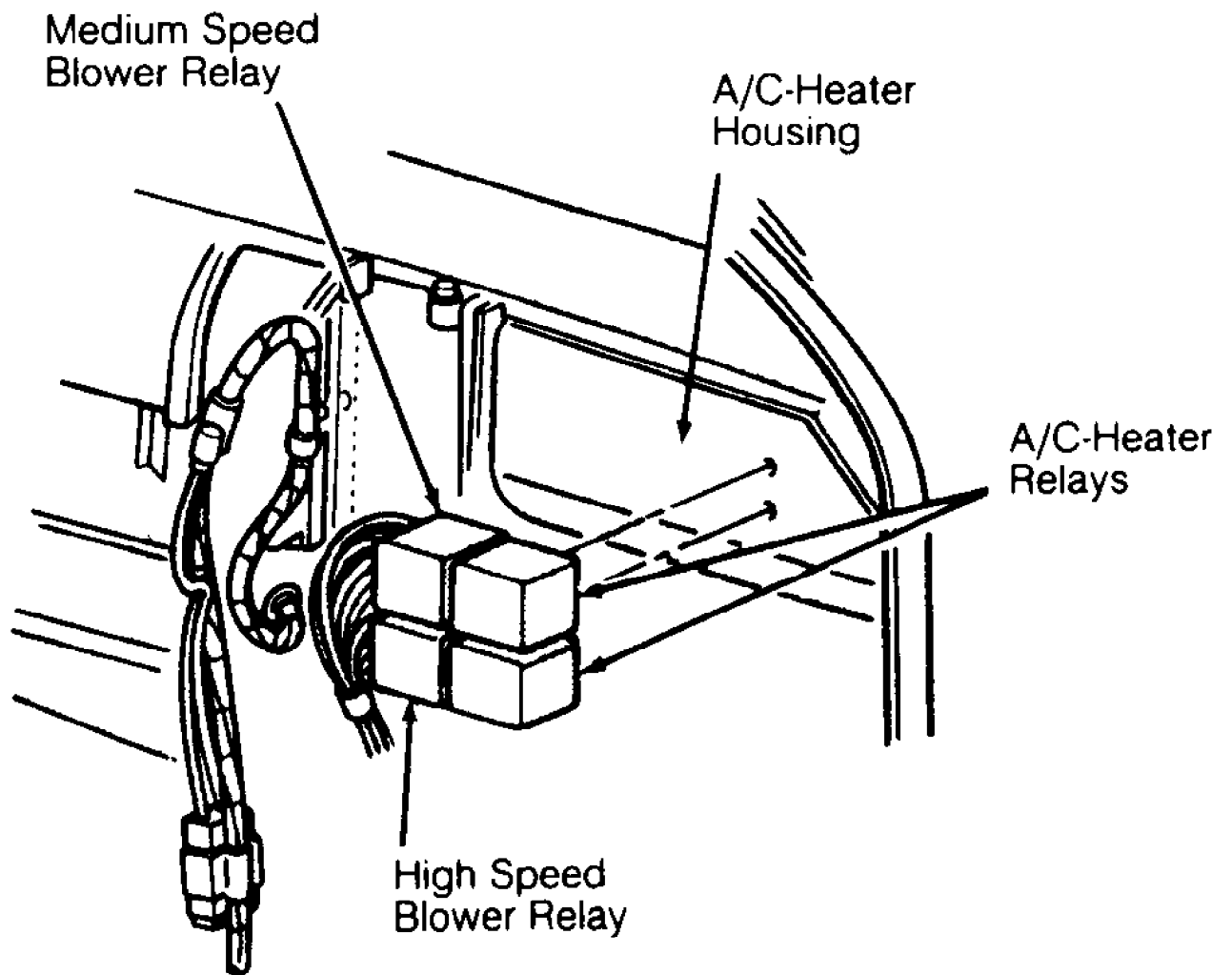


92F21621

**POWER DISTRIBUTION CENTER**

A/C Clutch Relay

In power distribution center,  
on right fender apron.

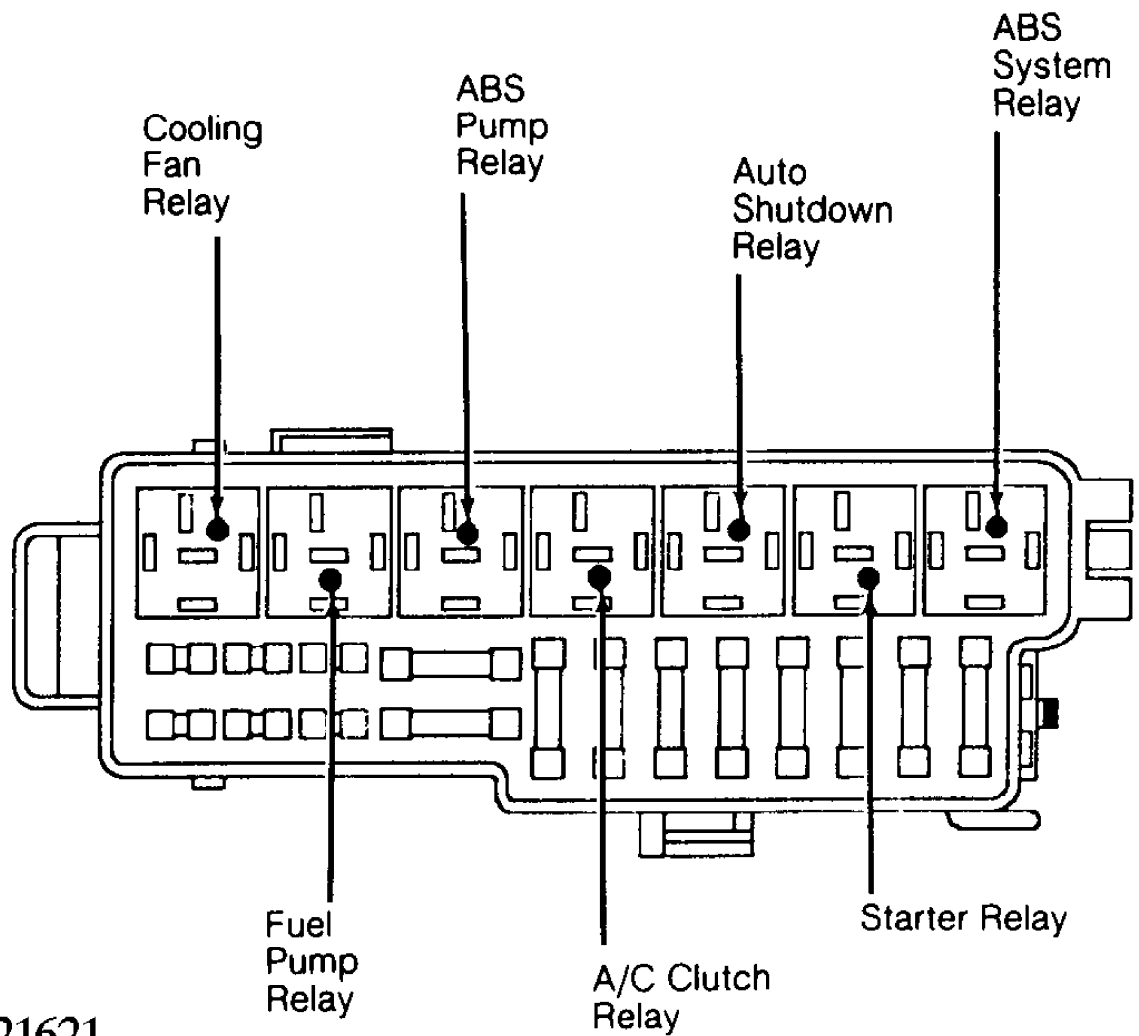


**92E21620**

A/C-Heater Relays

Behind right side of dash, on  
evaporator housing.

Auto Shutdown Relay

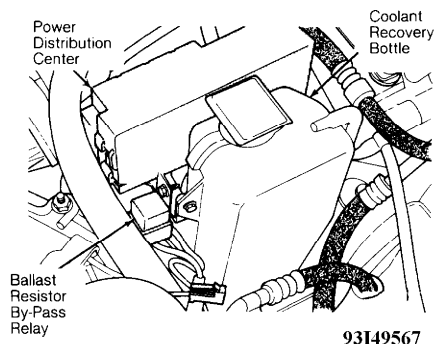


92F21621

## POWER DISTRIBUTION CENTER

Graphic No. 1

In power distribution center.

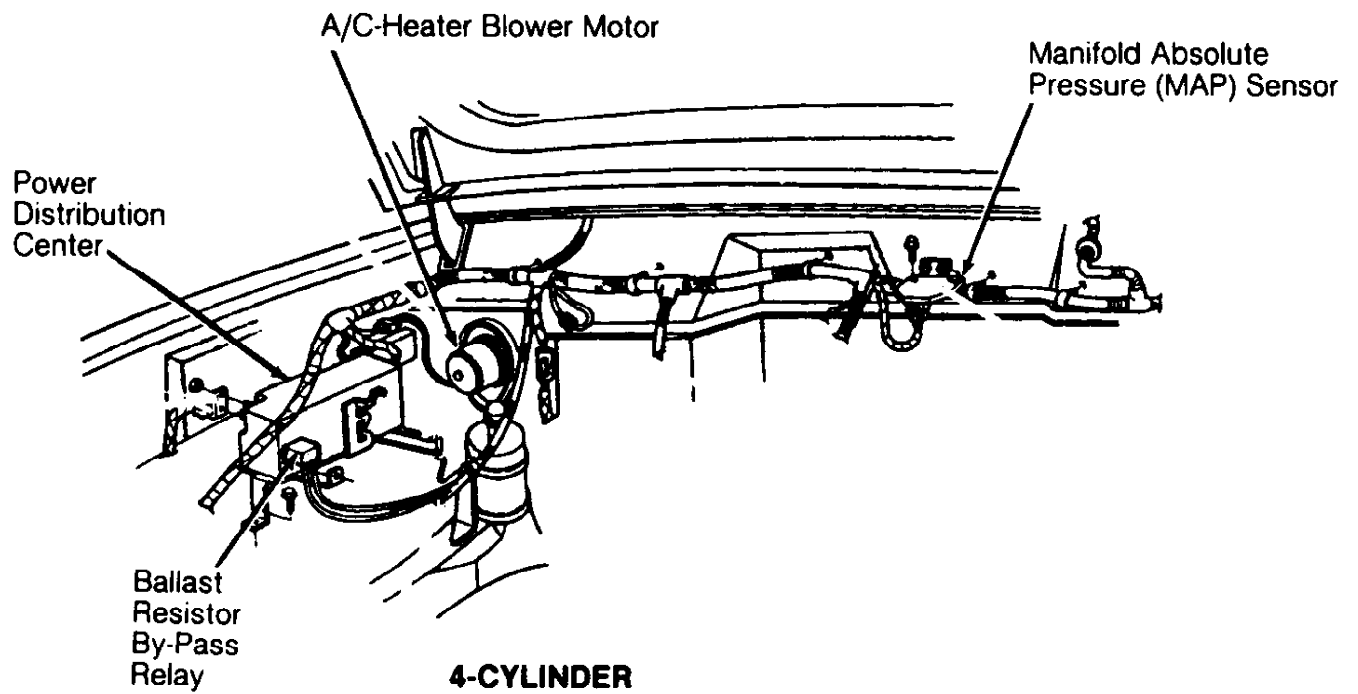


Graphic No. 2

In power distribution center.

Auxiliary Cooling Fan Relay

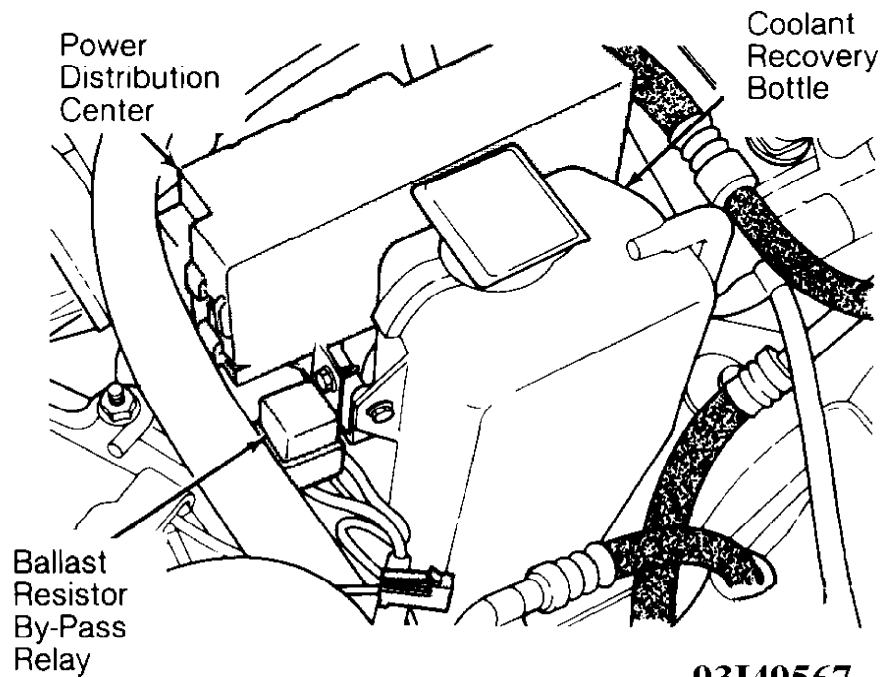
In power distribution center.



**92C21610**

Ballast Resistor By-Pass Relay  
4-Cylinder

On right fender apron, near  
power distribution center.

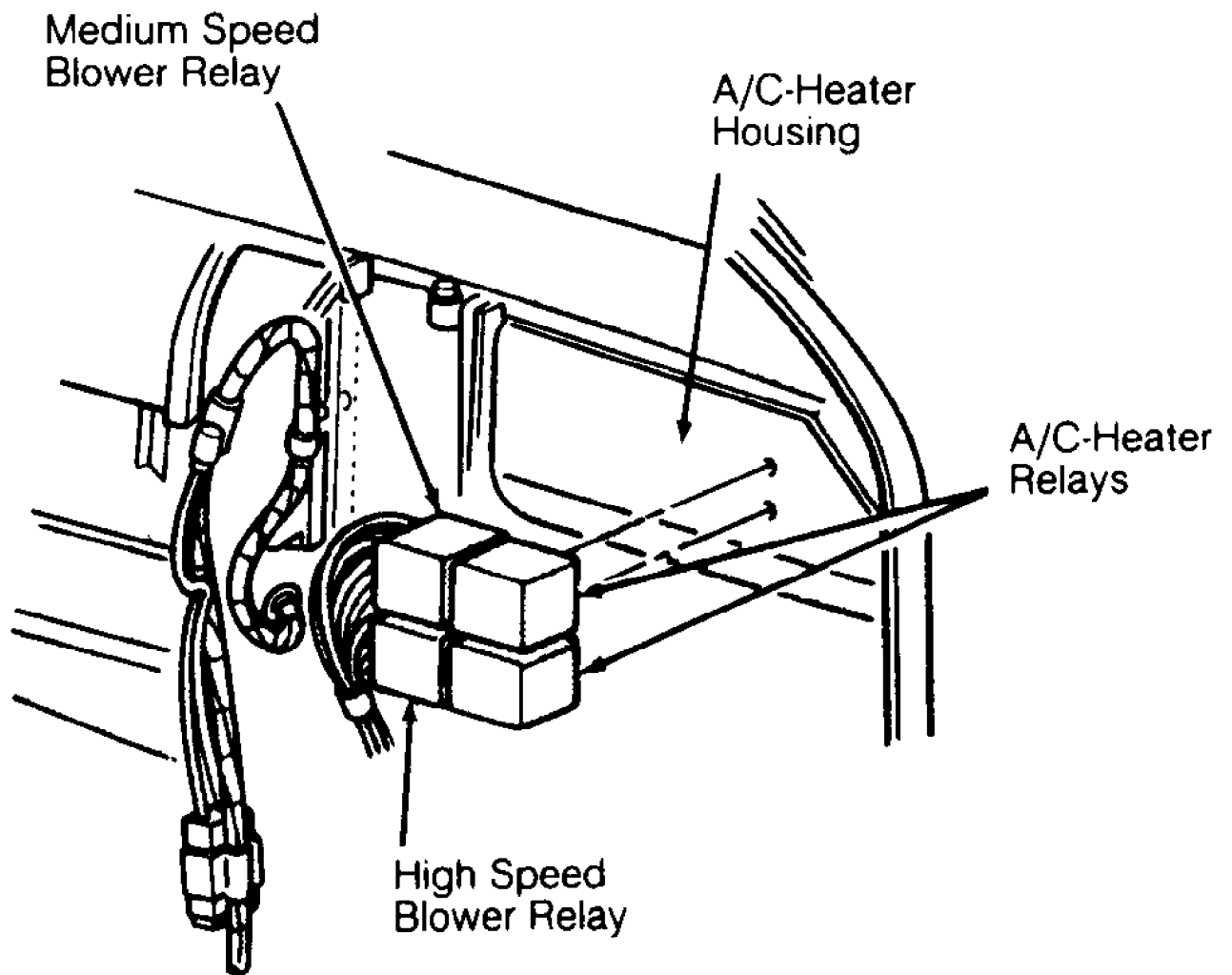


**93I49567**

On right fender apron, near  
power distribution center.

Graphic No. 2

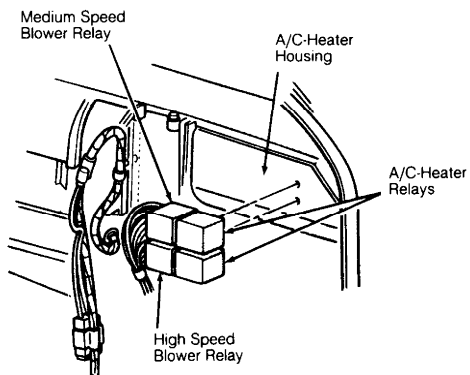
Blower Relays



**92E21620**

High Speed

Behind right side of dash, on evaporator housing.

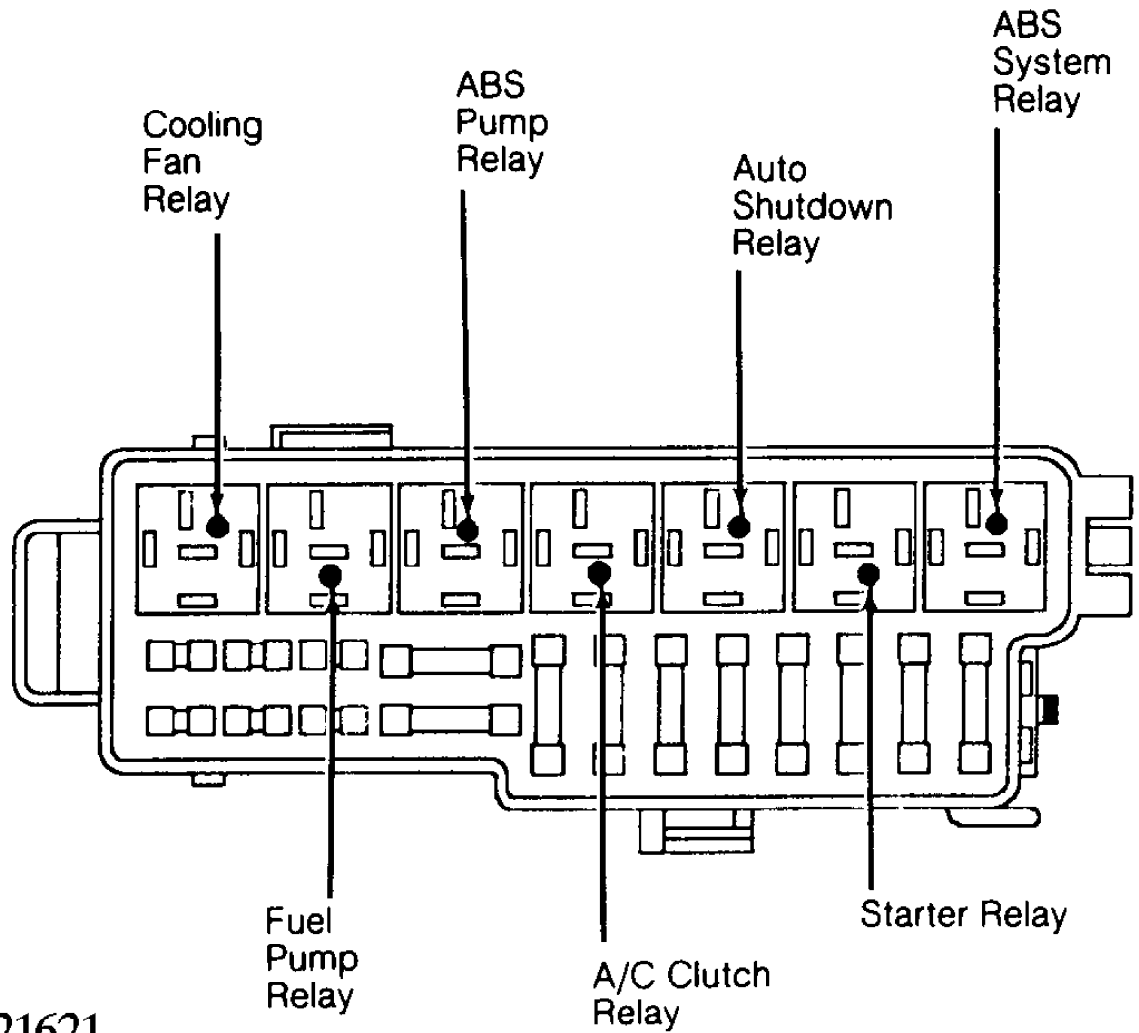


92E21620

Medium Speed

Behind right side of dash, on evaporator housing.

Cooling Fan Relay

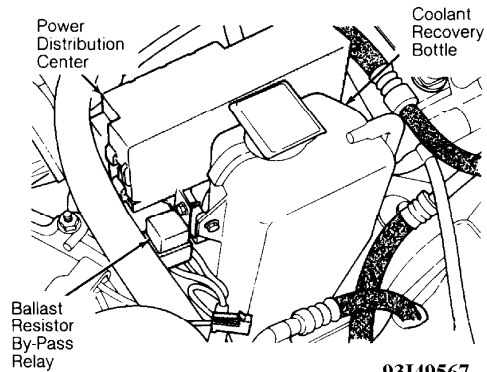


92F21621

## POWER DISTRIBUTION CENTER

Graphic No. 1

In power distribution center,  
on right fender apron.



93I49567

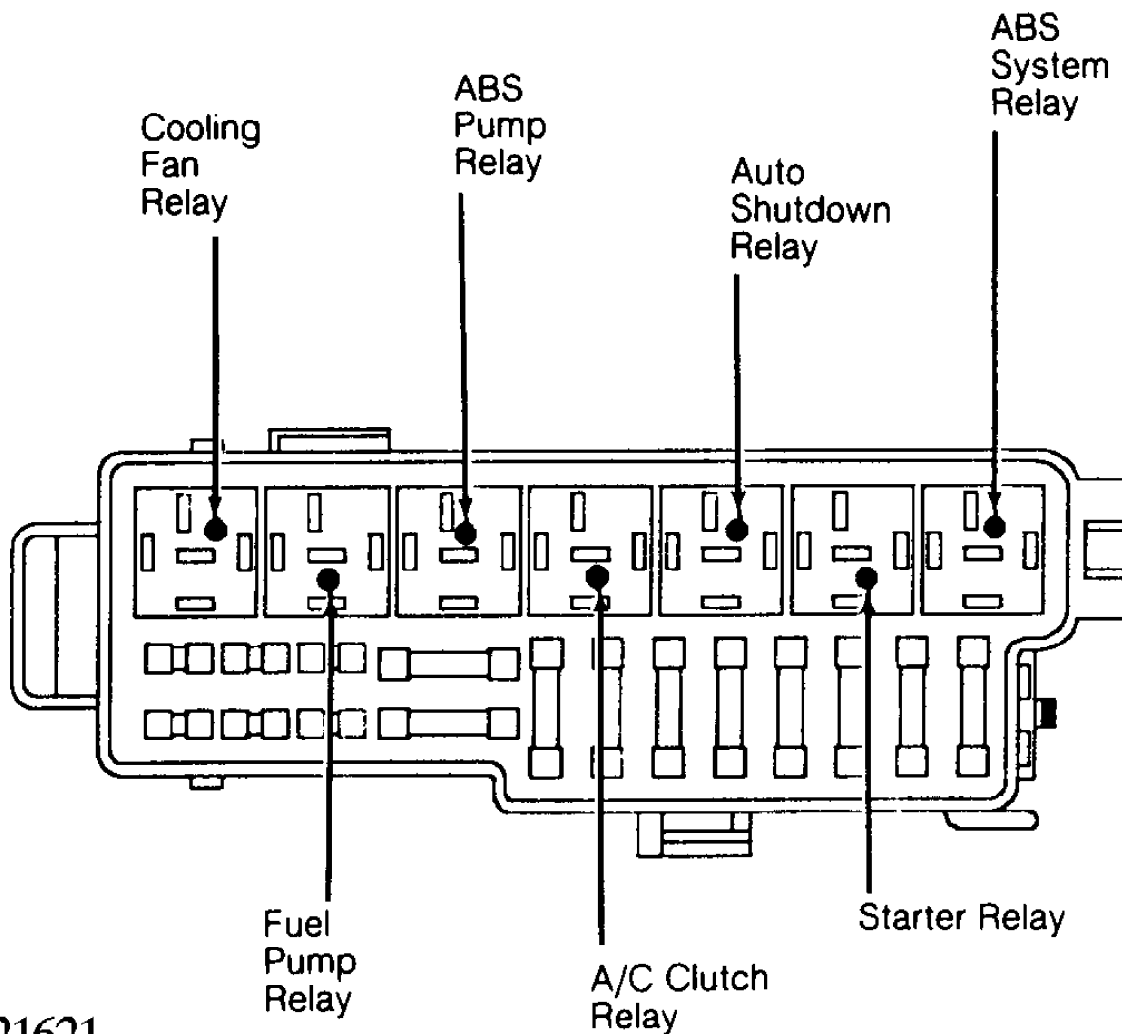
Graphic No. 2

In power distribution center,  
on right fender apron.

Foglight Relay

Behind left head light, on  
wheelwell.

Fuel Pump Relay

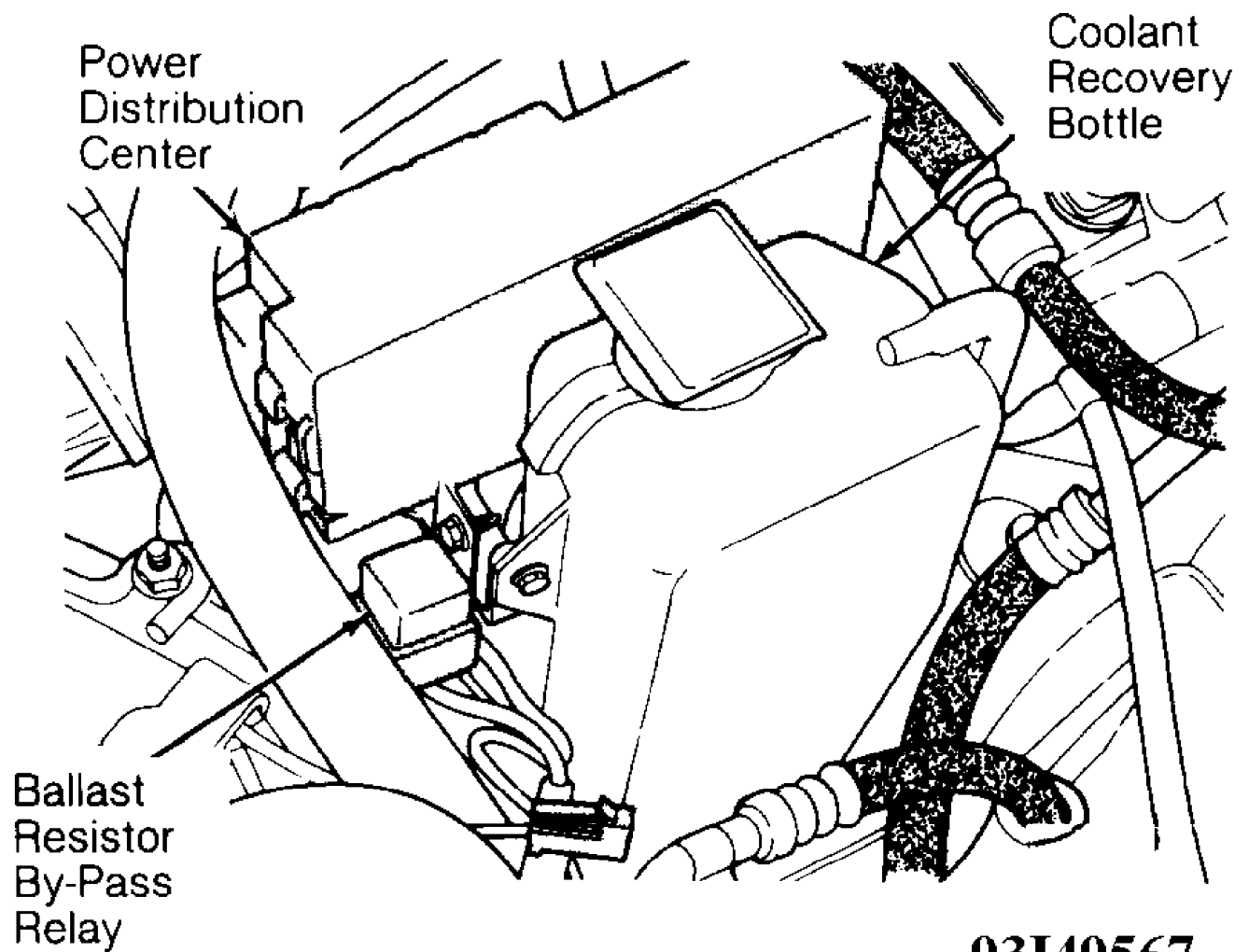


92F21621

### POWER DISTRIBUTION CENTER

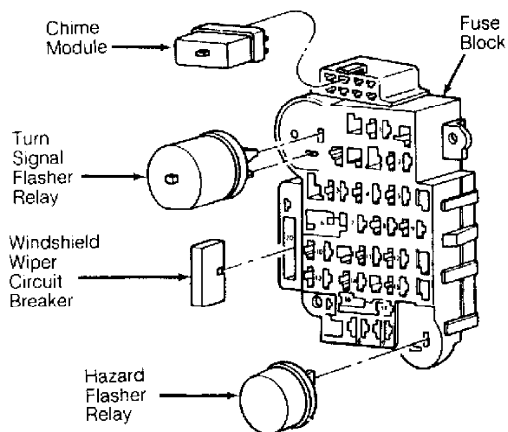
Graphic No. 1

In power distribution center,  
on right fender apron.



Graphic No. 2

In power distribution center,  
on right fender apron.



Hazard Flasher Relay

Horn Relay

Power Antenna Relay

In fuse block.

On relay center.

Under right side of dash,



behind glove box.

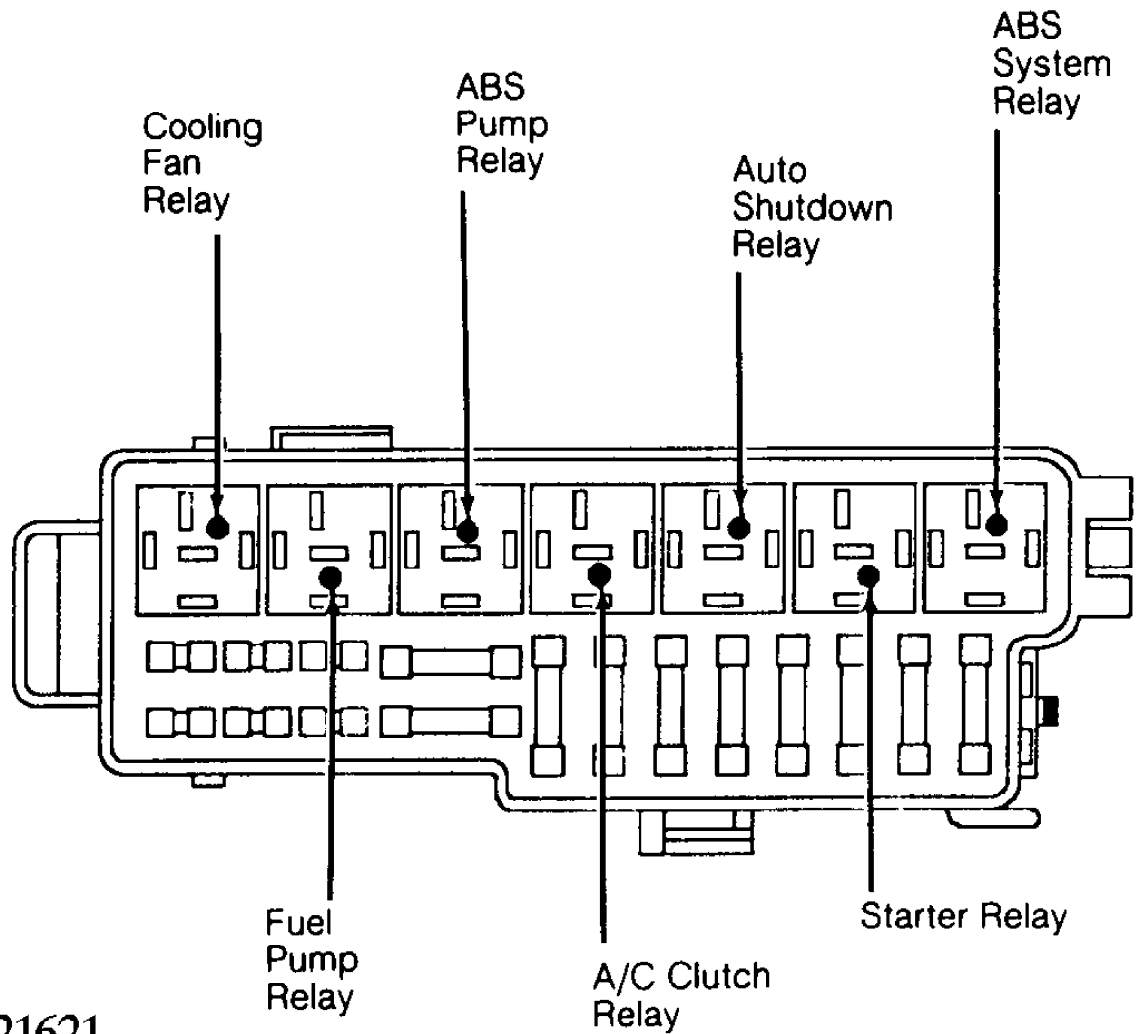
Radio/Clock Illumination Relay

On relay center.

Rear Window Defogger Relay

On relay center.

Starter Relay

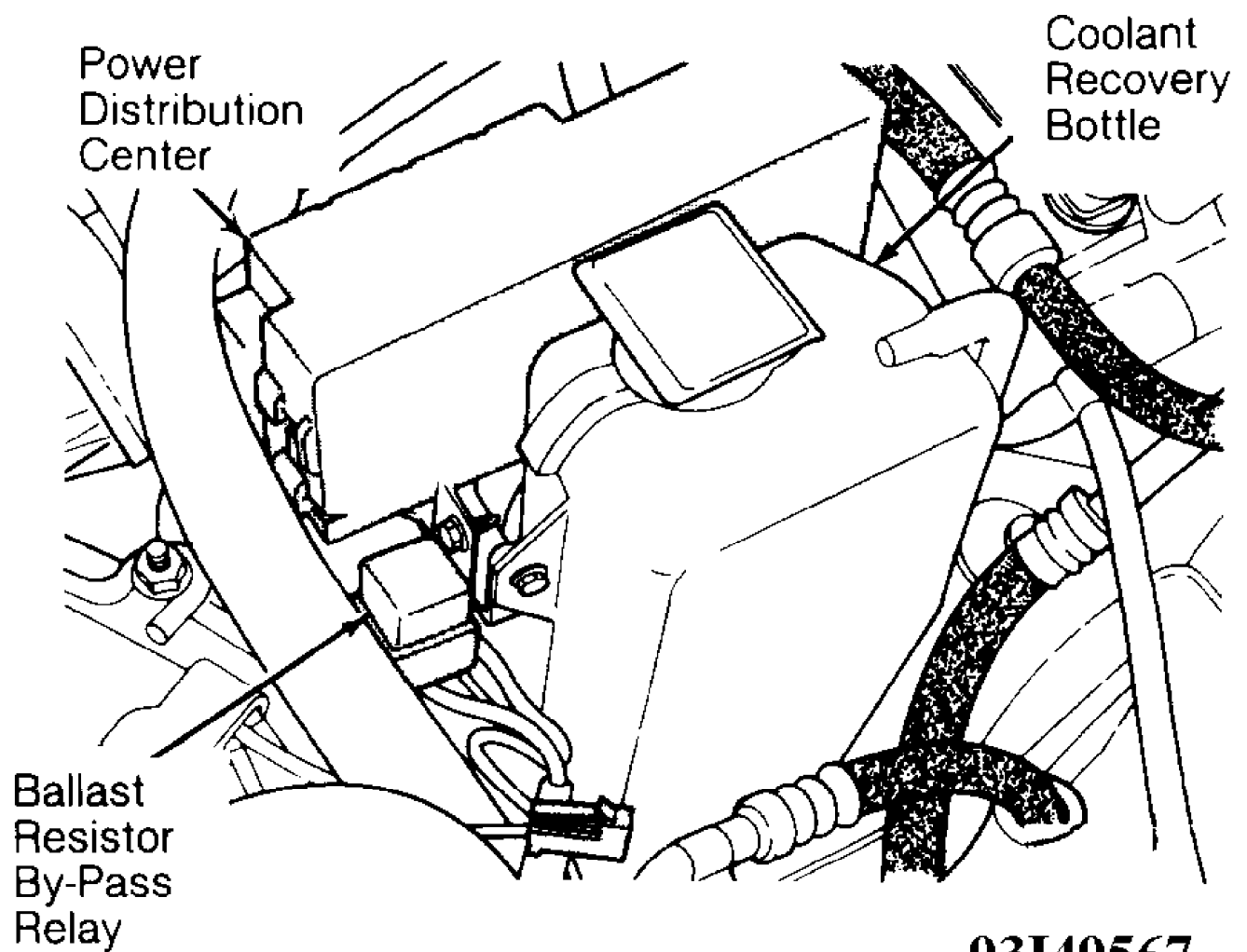


92F21621

### POWER DISTRIBUTION CENTER

Graphic No. 1

In power distribution center,  
on right fender apron.



**93I49567**

Graphic No. 2

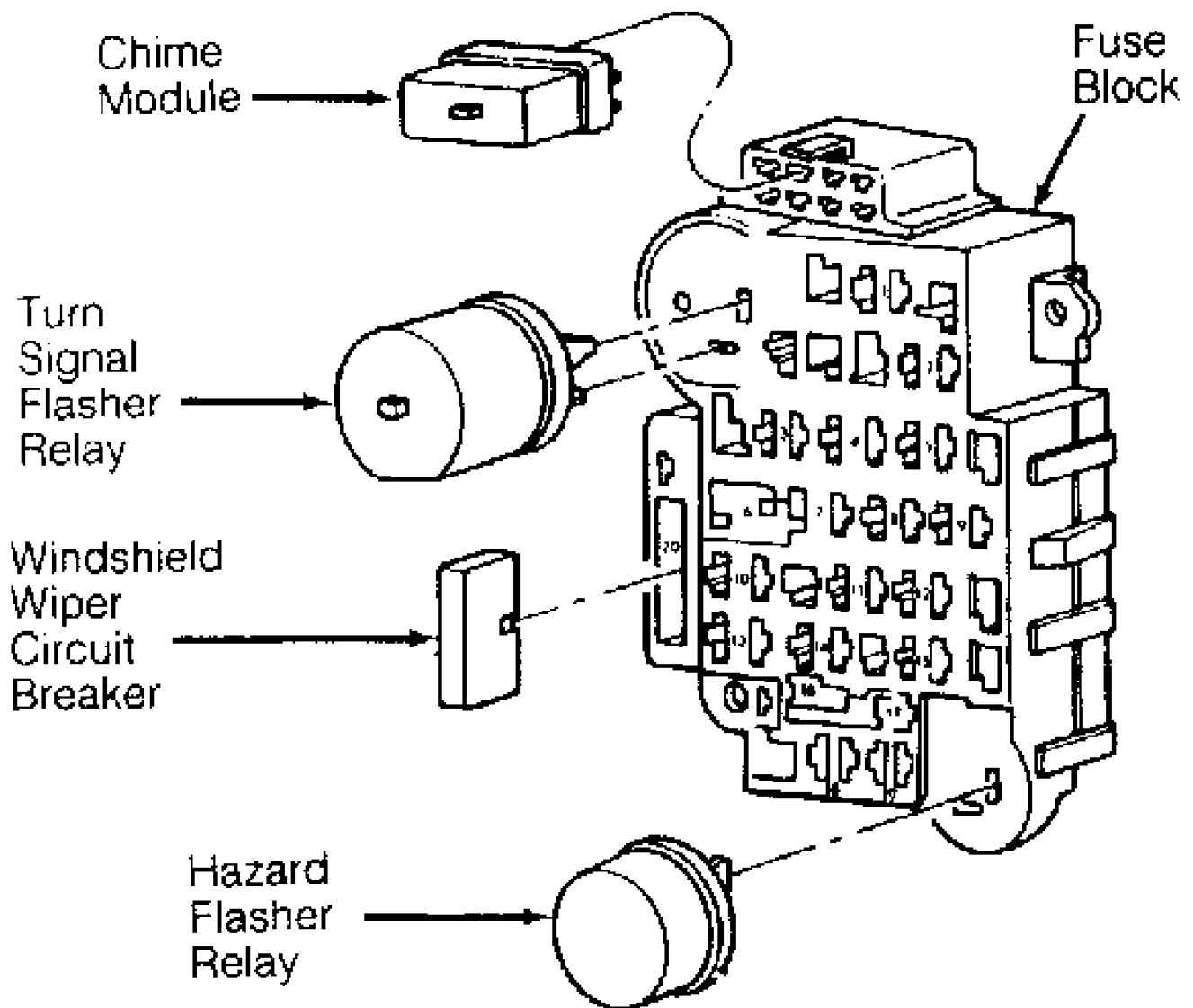
In power distribution center,  
on right fender apron.

Trailer Towing Relays  
Brake Lights

Behind left rear quarter trim  
panel.

Left & Right Turn Signals

Behind left rear quarter trim  
panel.

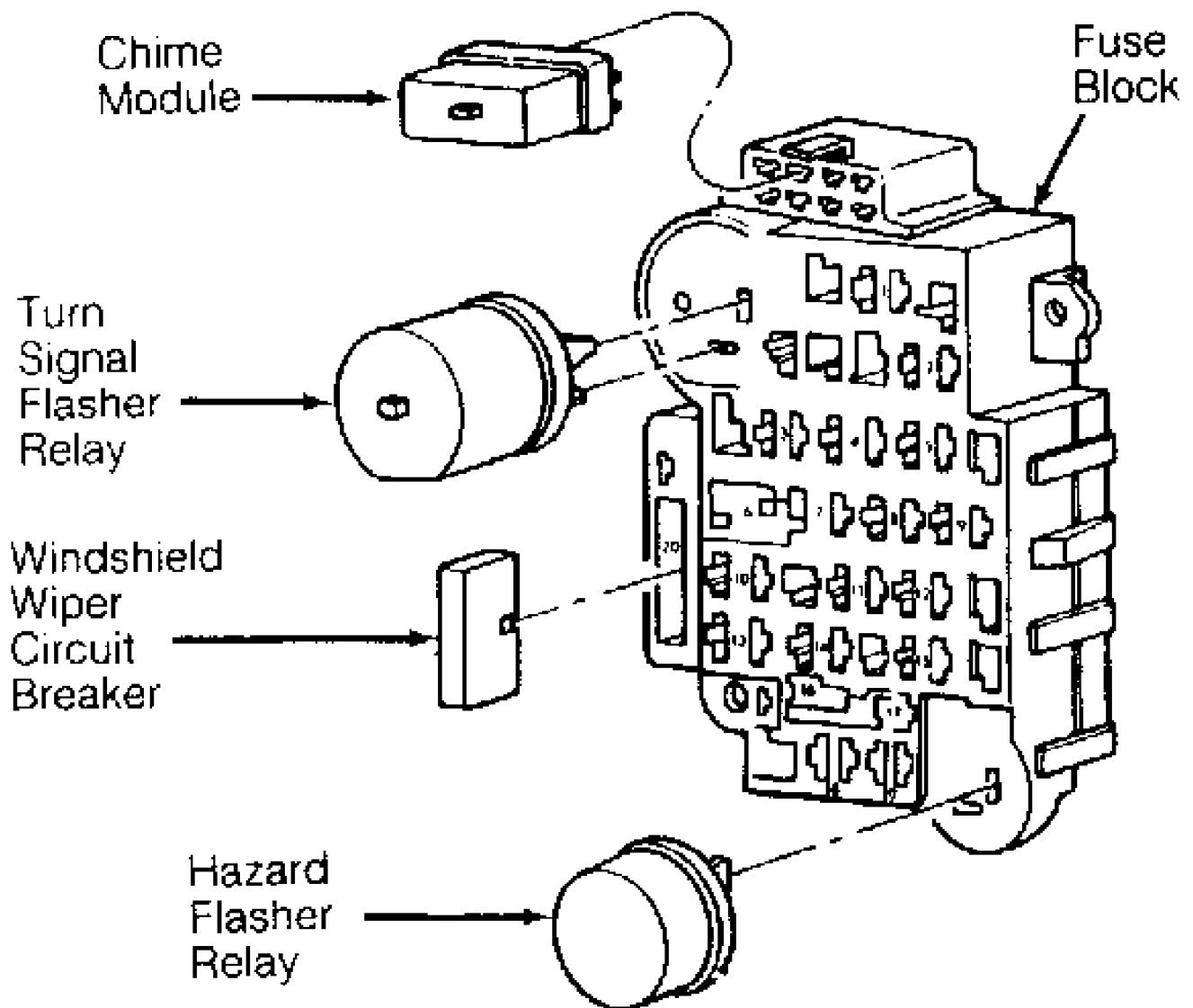


Turn Signal Flasher Relay

In fuse block.

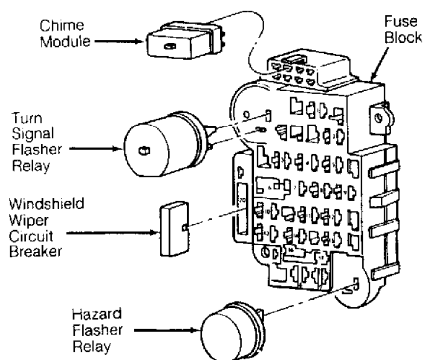
### CIRCUIT PROTECTION DEVICES

Component	Component Location
Circuit Breakers Power Windows	In fuse block.
Trailer Tow	Taped to harness, left rear quarter panel.



Windshield Washer/Wiper

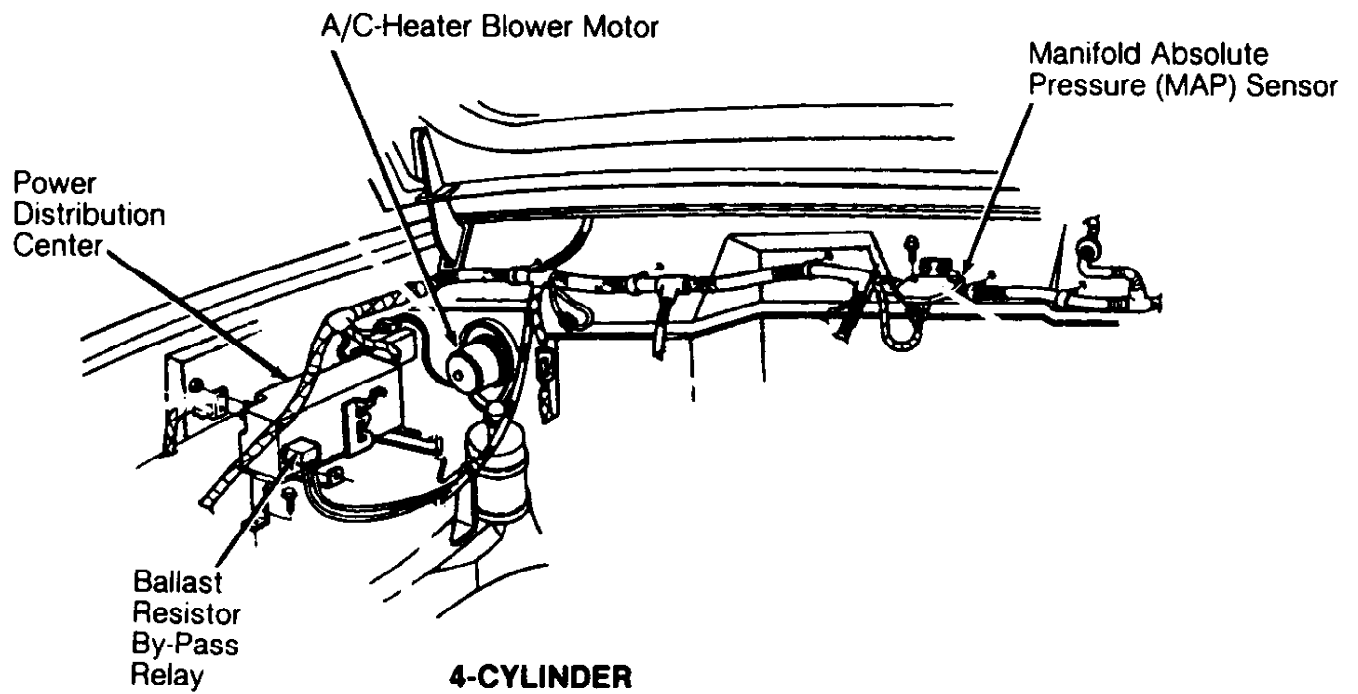
In fuse block.



Fuse Block

Under left side of dash.

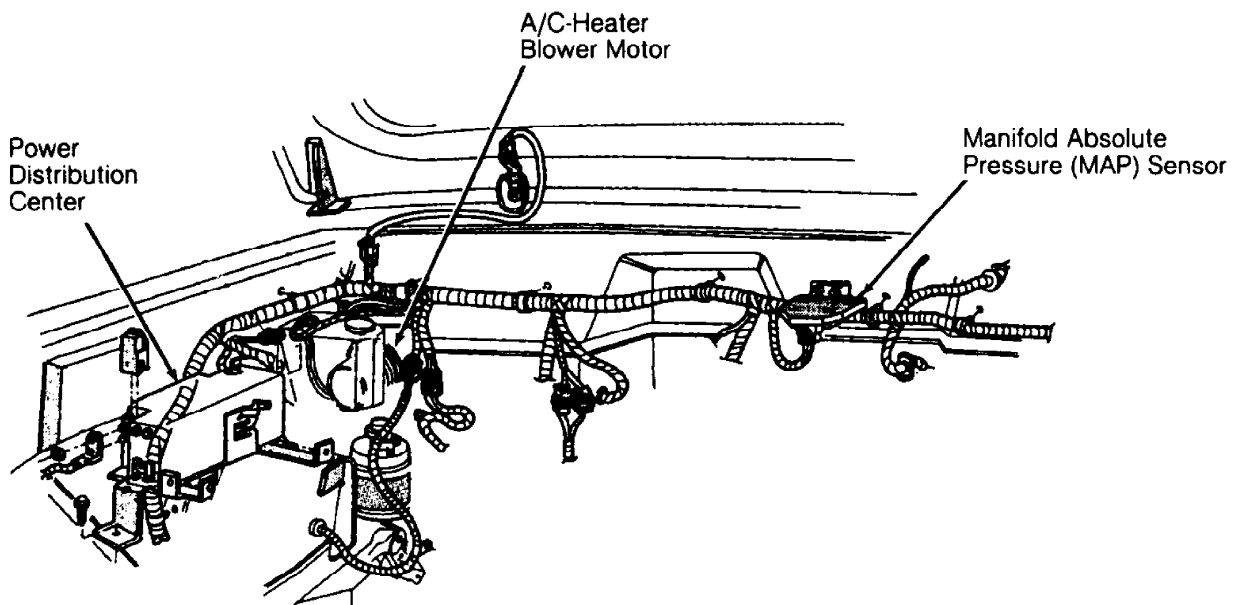
Power Distribution Center



92C21610

(4-Cylinder)

On right fender apron.

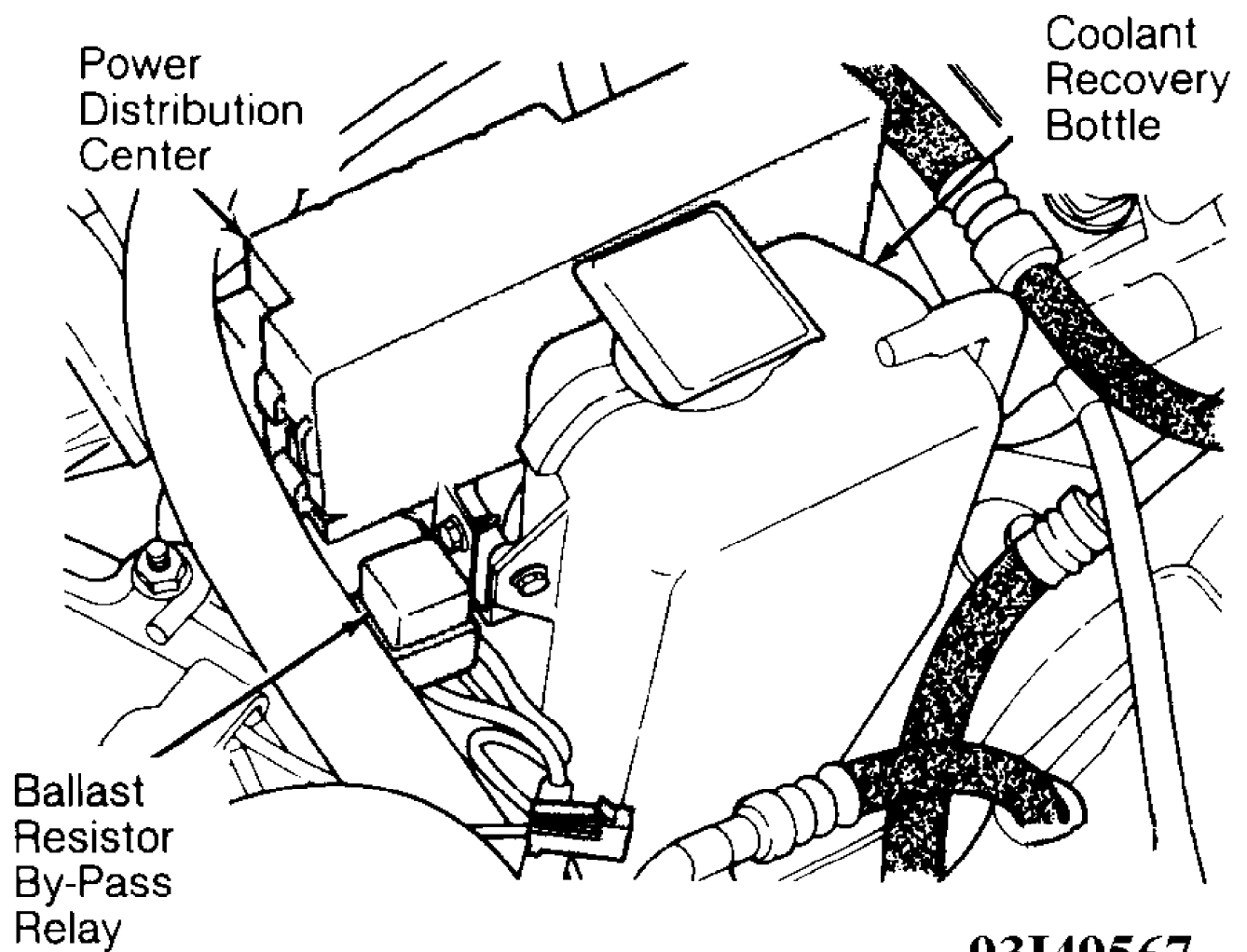


92G21614

**6-CYLINDER**

(6-Cylinder)

On right fender apron.



**93I49567**

Graphic No. 3

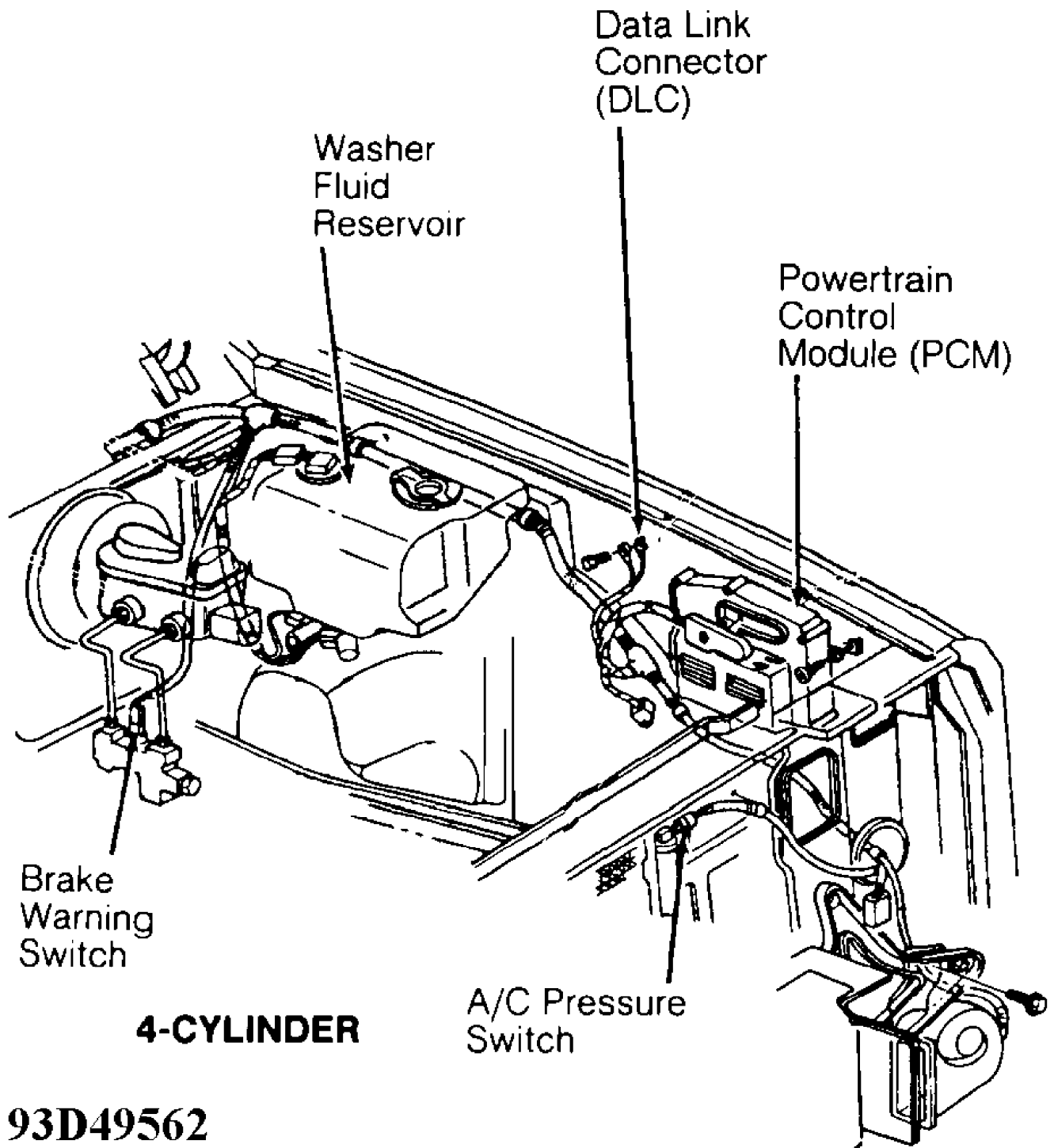
On right fender apron.

Relay Center

On lower dash trim panel,  
right of steering column.

## CONTROL UNITS

Component	Component Location
ABS Module	Under left rear seat.
Daytime Running Lights (DRL) Module	On right rear of engine compartment, near firewall.
ECAT Module	Behind right side of dash.
Headlight Delay Module	Under dash, next to headlight switch.
Intermittent Wiper Module	Under left side of dash, left of steering column.
Keyless Entry Module	Between sun visors.



**4-CYLINDER**

**93D49562**

Powertrain Control Module (PCM)  
4-Cylinder

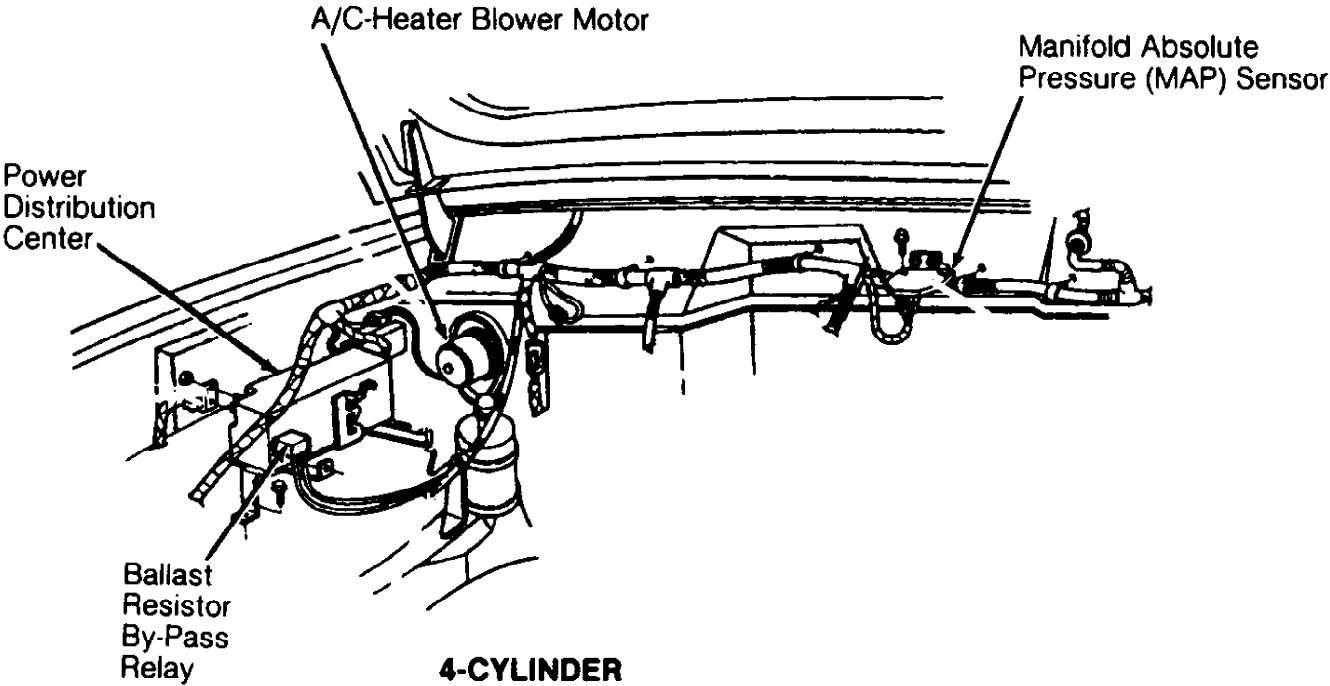
Security System Module

On left front fender apron,  
behind air cleaner.

On bracket, left side of  
A/C-heater housing.

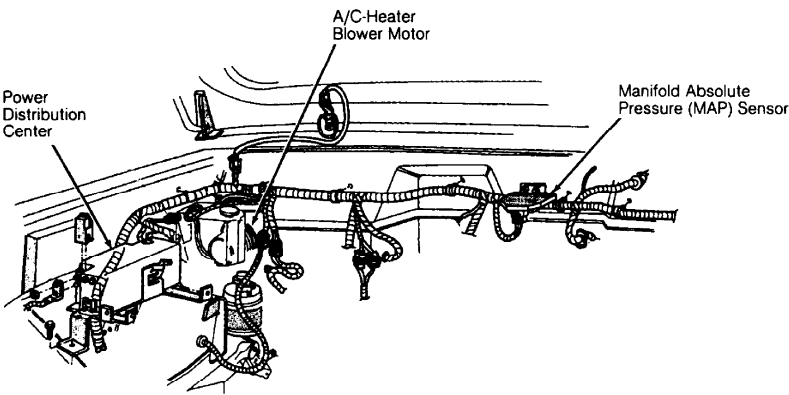
# MOTORS

Component	Component Location
ABS Pump Motor	At right rear of engine compartment, near shock tower.
A/C-Heater Blower Motor	



92C21610

(4-Cylinder)	On right engine compartment firewall.
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92G21614

(6-Cylinder)	On right engine compartment firewall.
--------------	---------------------------------------

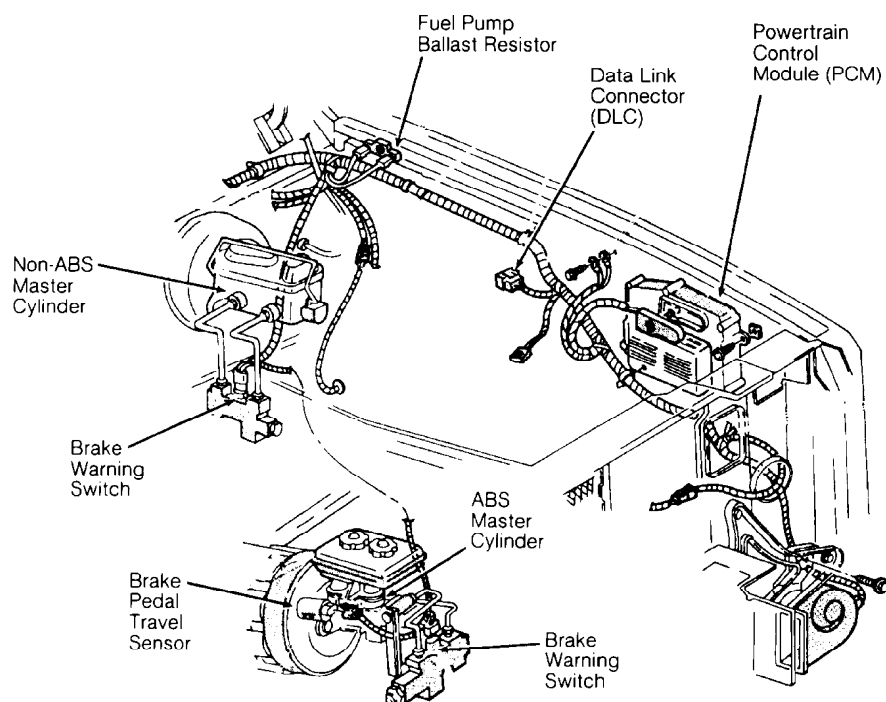
Fuel Pump	Inside fuel tank.
-----------	-------------------



Idle Air Control Motor	On throttle body assembly.
Washer Motor Front	On bottom of washer fluid reservoir, in engine compartment.
Rear	On bottom of washer fluid reservoir, in engine compartment.
Windshield Wiper Motor	Behind left side of firewall, under cowl trim panel.

## SENDING UNITS & SENSORS

Component	Component Location
ABS Accumulator Sensor	On master cylinder, to right of reservoir.
ABS Wheel Sensors	At each wheel.
Brake Fluid Level Sensor	In master cylinder reservoir.
Brake Pad Wear Sensors	In both inner front brake pads.



93F49564

### 6-CYLINDER

Brake Pedal Travel Sensor	On brake master cylinder.
---------------------------	---------------------------

Camshaft  
Position  
Sensor

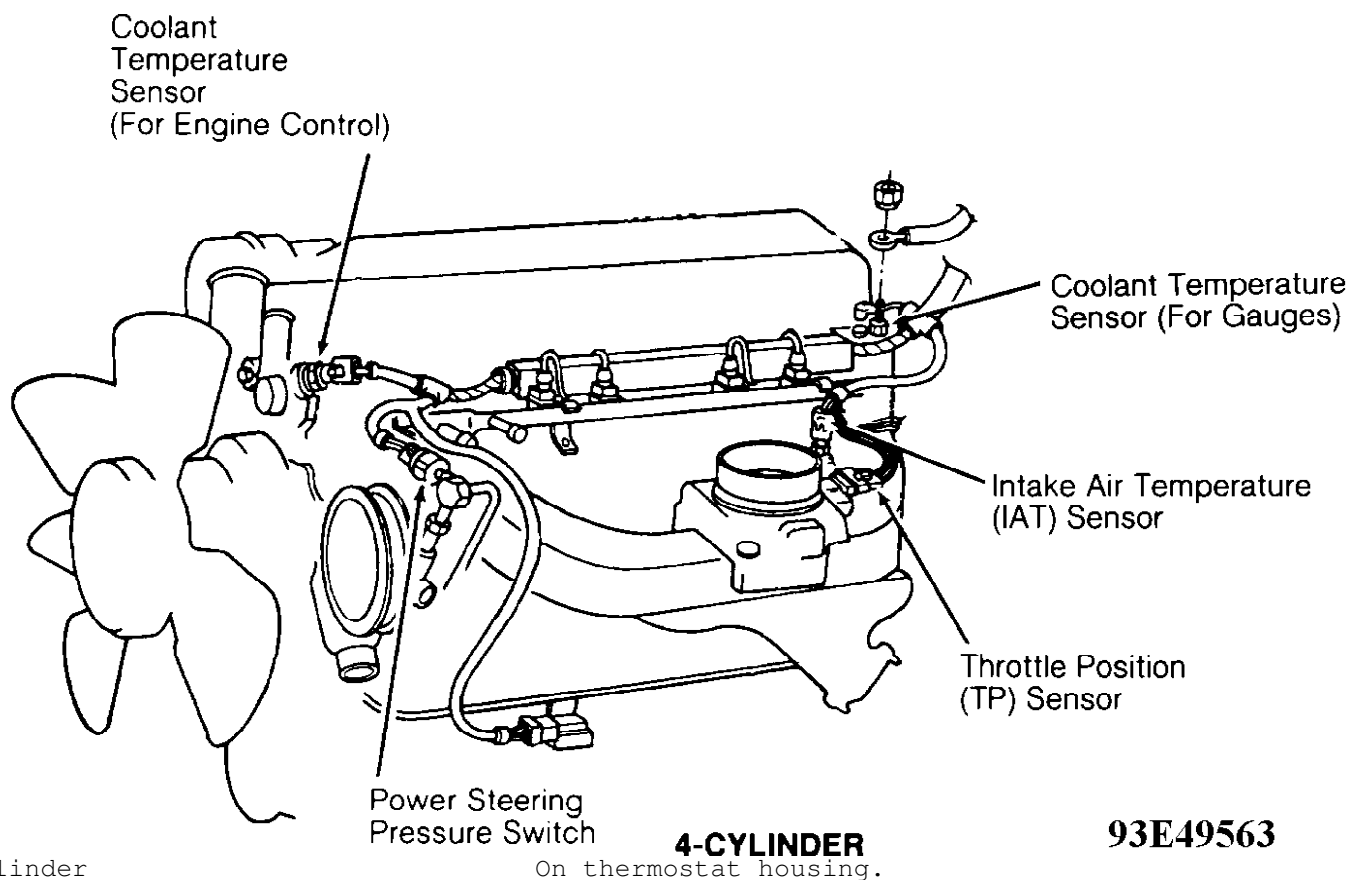
Distributo  
Assembly

**93J49568**

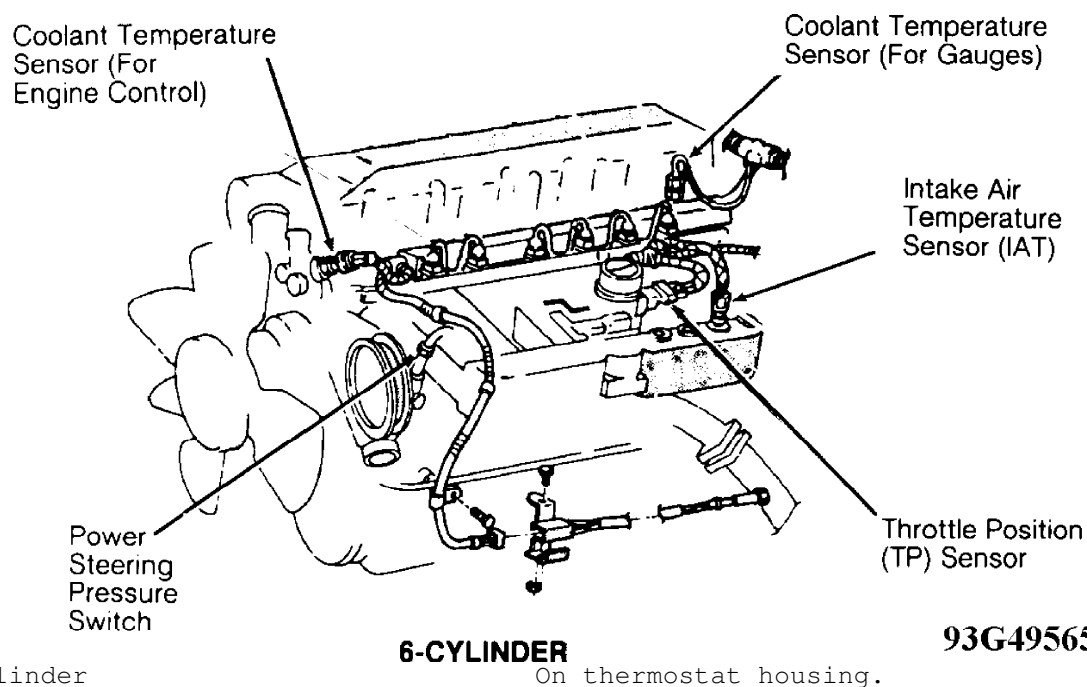
Camshaft Position Sensor

Inside ignition distributor  
assembly.

Coolant Temperature Sensor  
For Engine Control

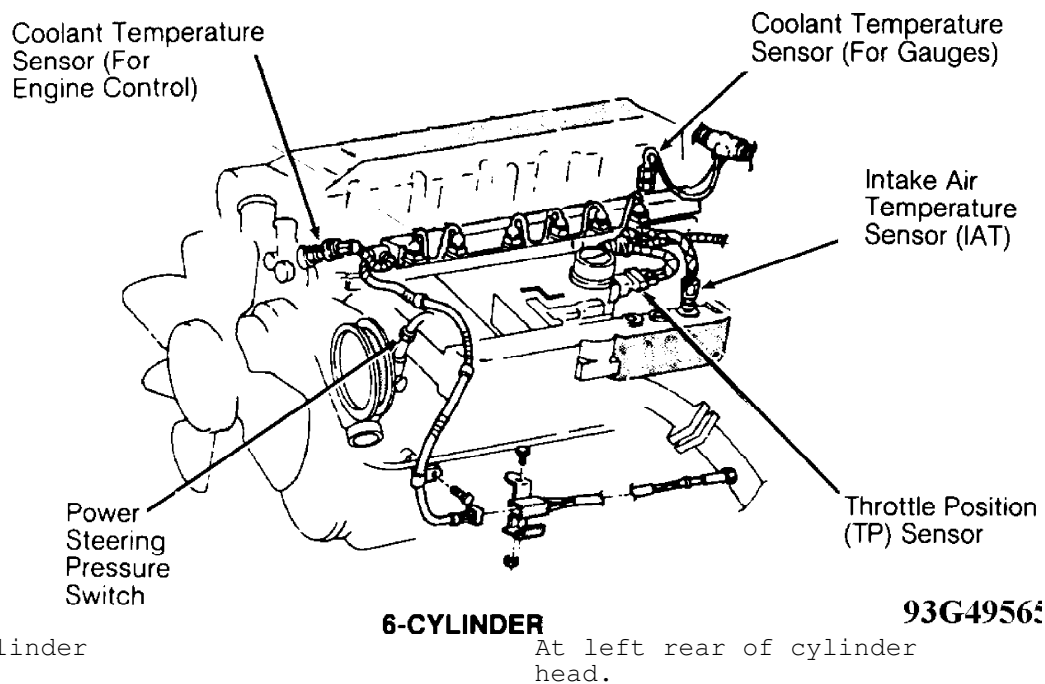
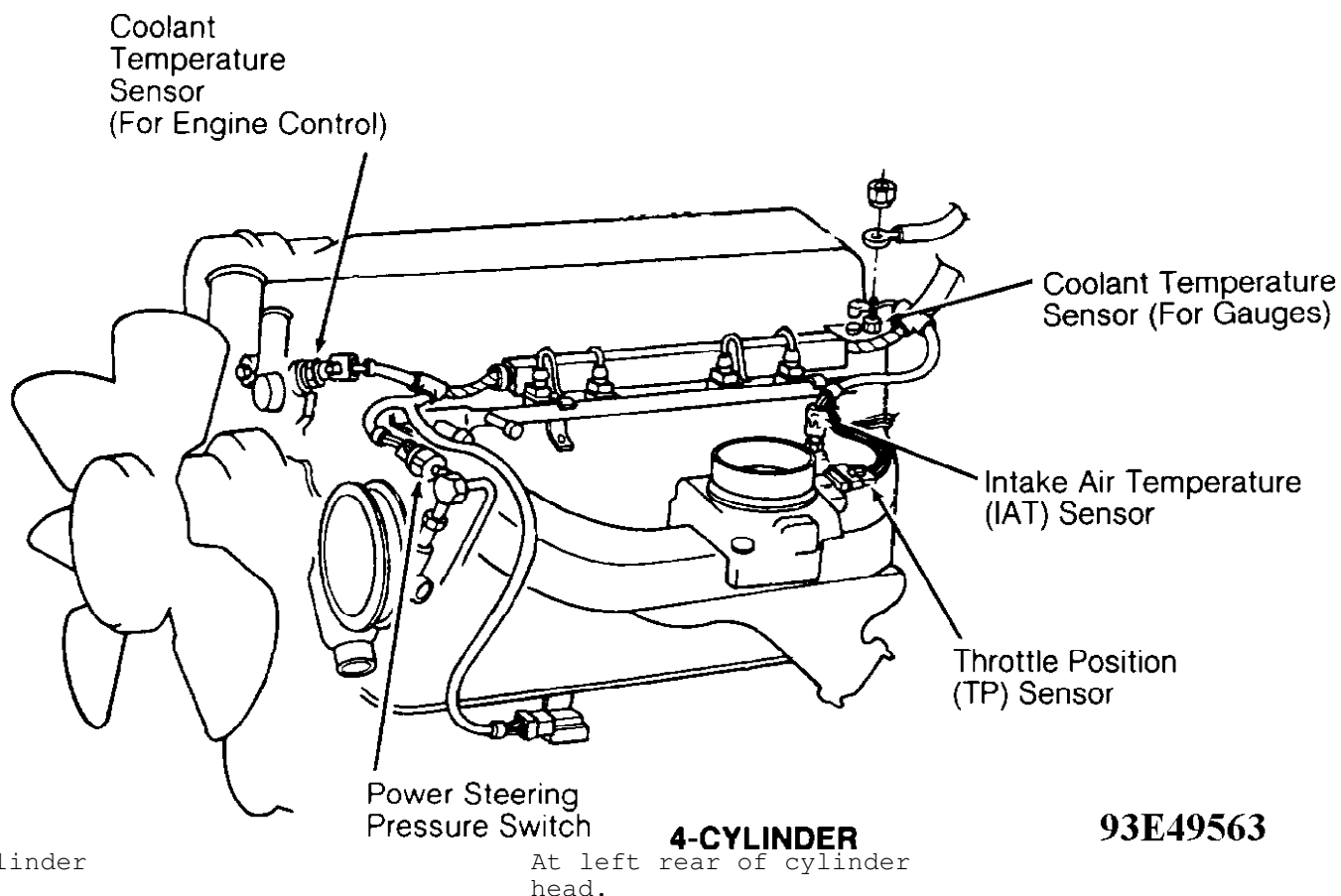


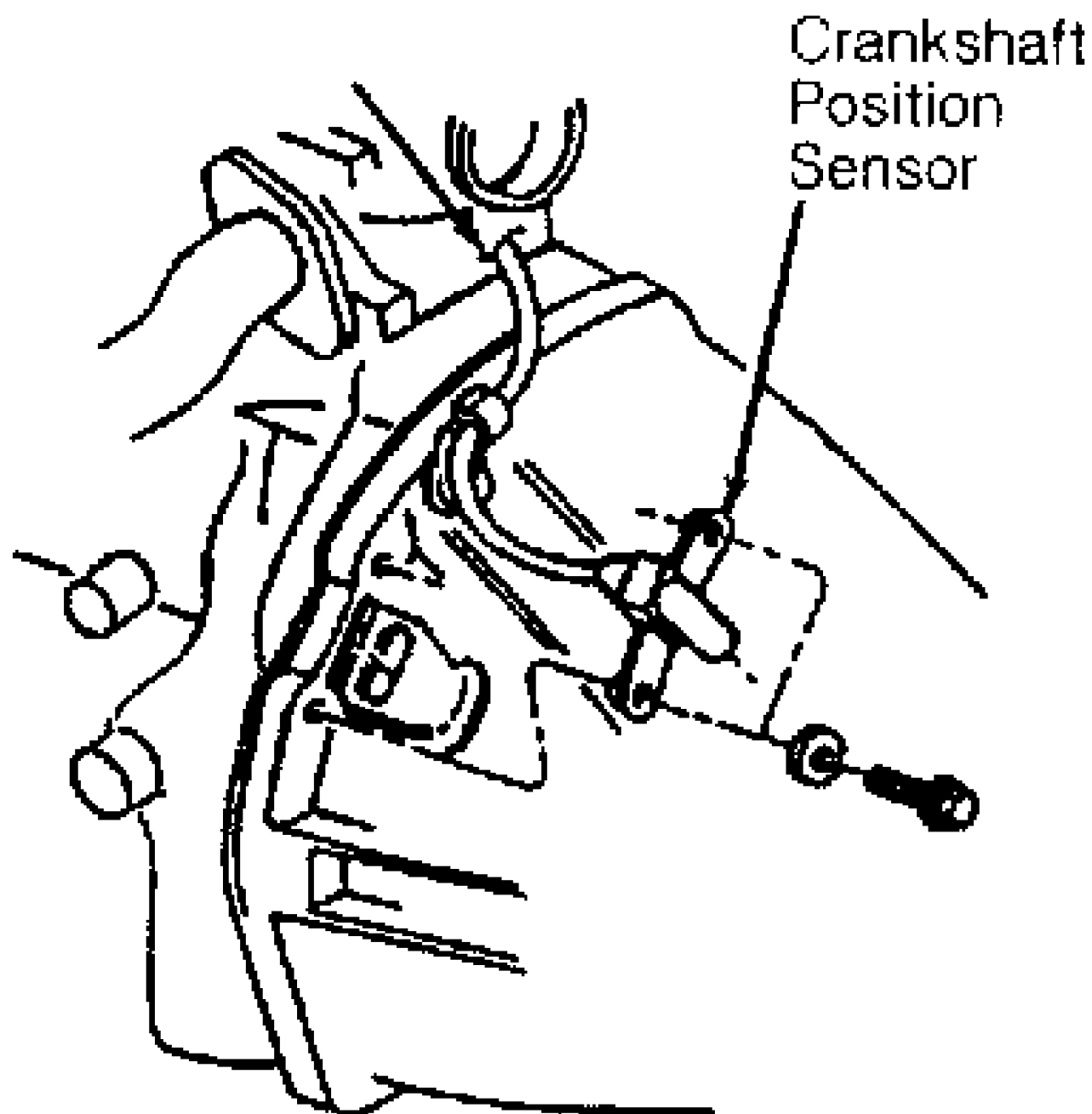
4-Cylinder



6-Cylinder

For Gauges





Crankshaft Position Sensor

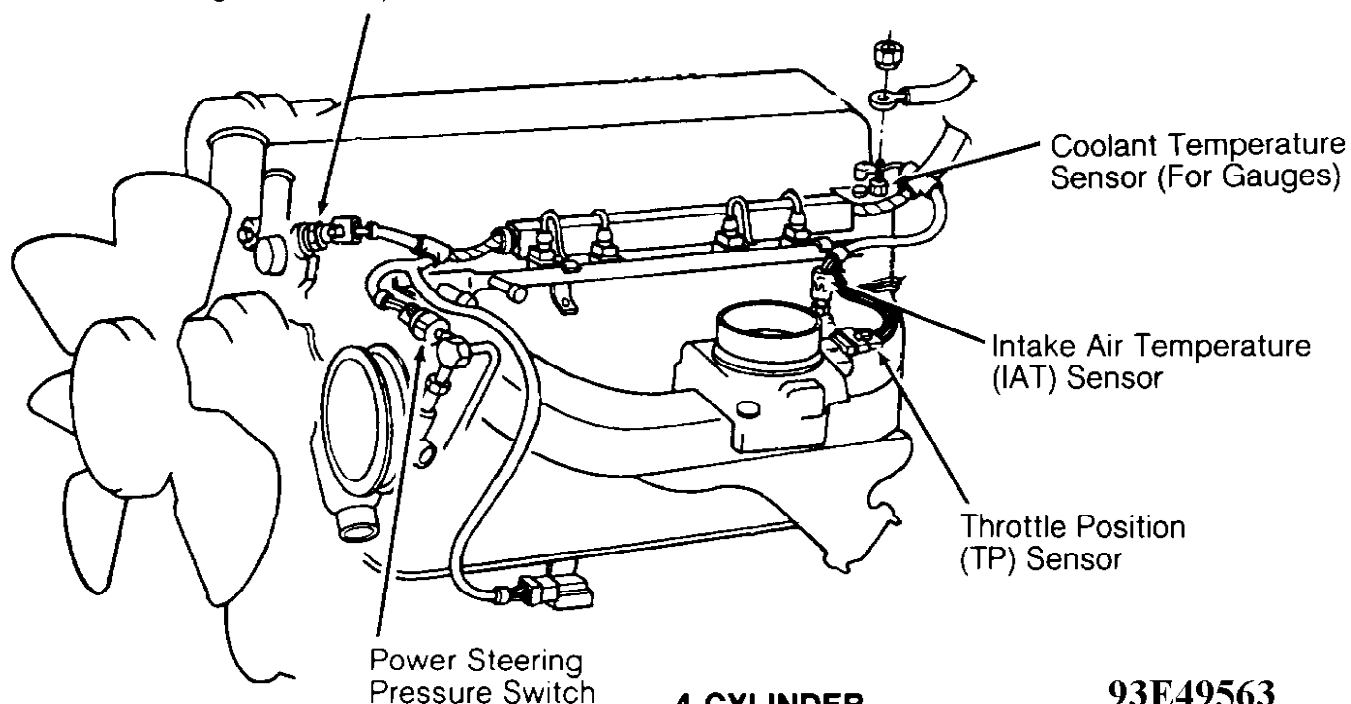
On left side of transmission bellhousing.

Fuel Gauge Sending Unit

In fuel tank, part of fuel pump assembly.

Intake Air Temperature Sensor (IAT)

Coolant Temperature Sensor (For Engine Control)



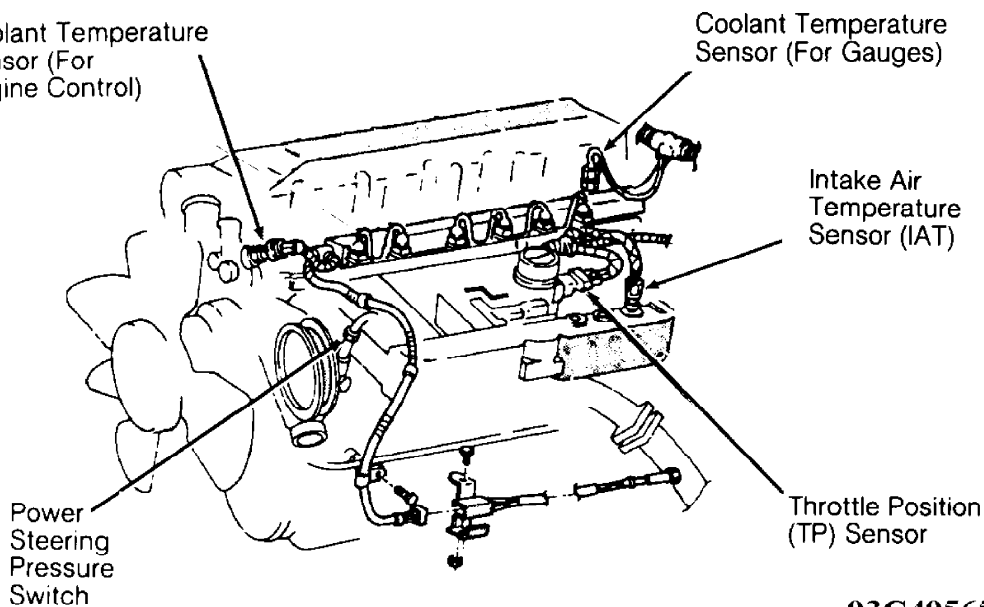
# **4-CYLINDER**

**93E49563**

4-Cylinder

On intake air plenum, near throttle body.

Coolant Temperature Sensor (For Engine Control)



# **6-CYLINDER**

**93G49565**

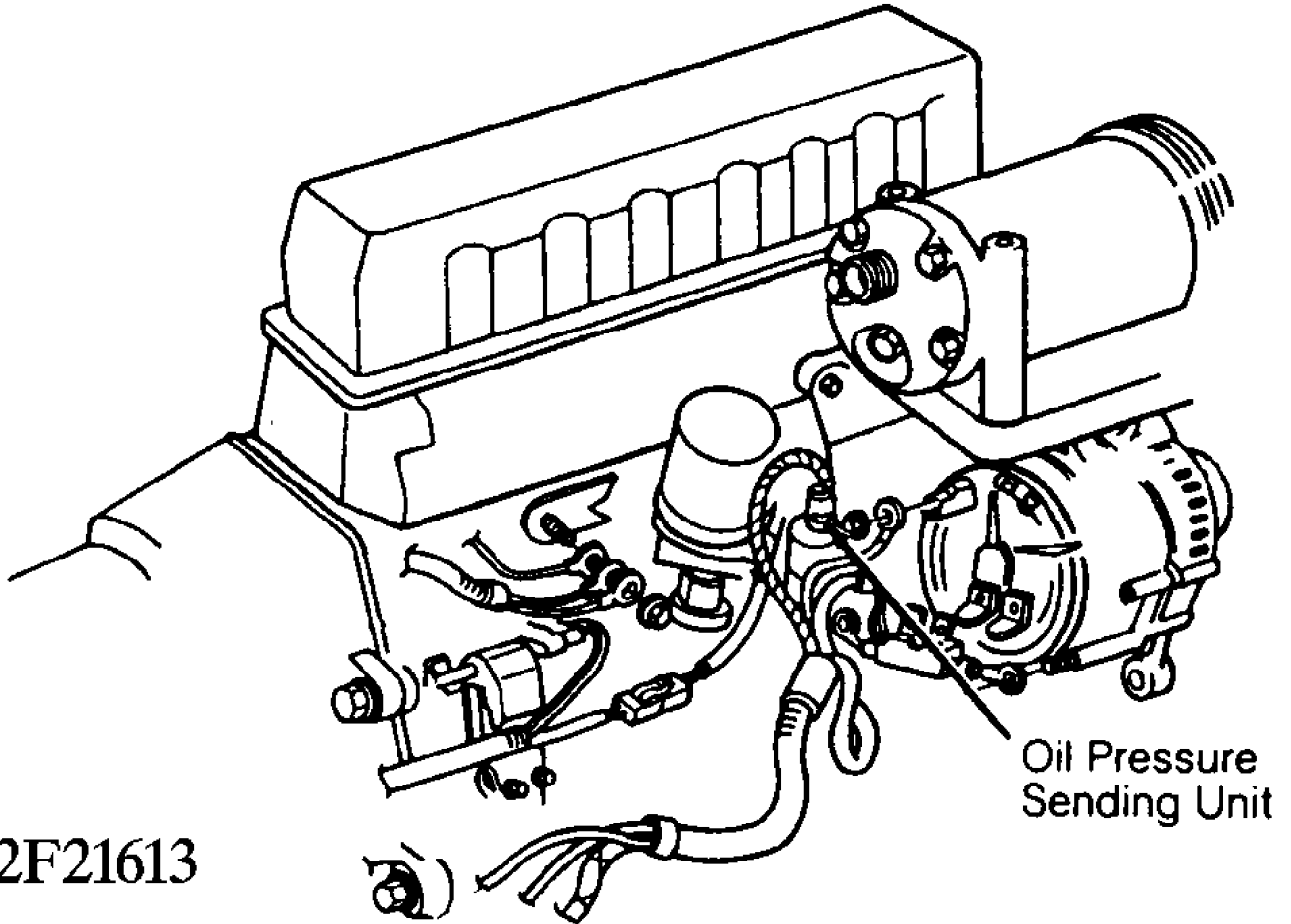
6-Cylinder

On intake air plenum, near throttle body.

Manifold Absolute Pressure Sensor (MAP)

On center of firewall.

Oil Pressure Sending Unit

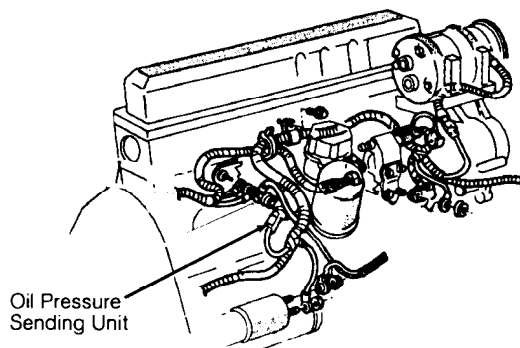


92F21613

**4-CYLINDER**

(4-Cylinder)

On right side of engine block.

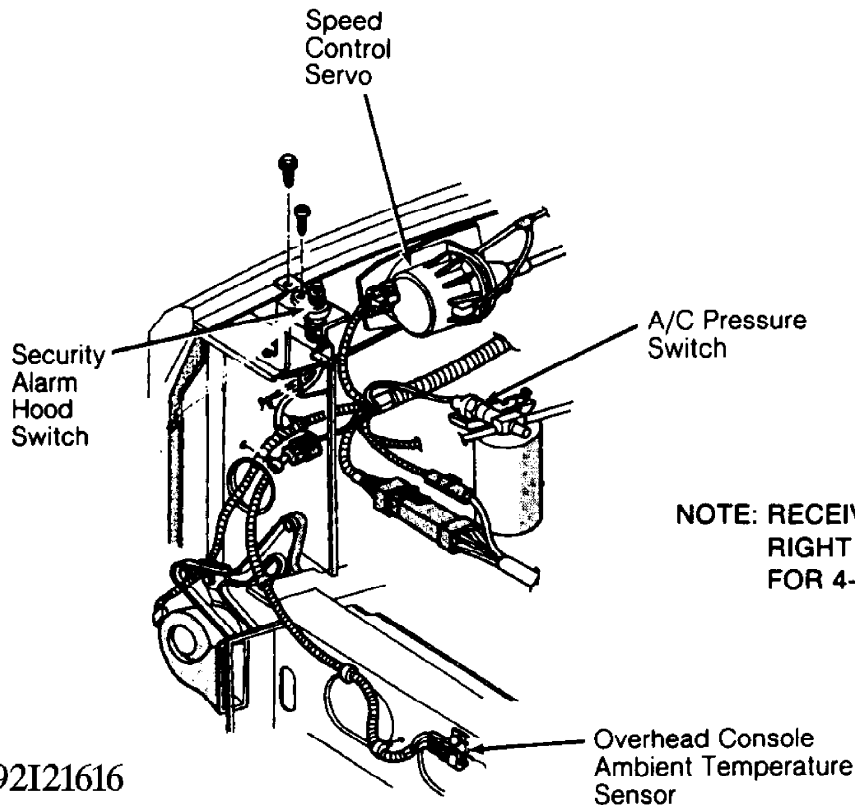


92A21618

**6-CYLINDER**

(6-Cylinder)

On right side of engine block.



92I21616

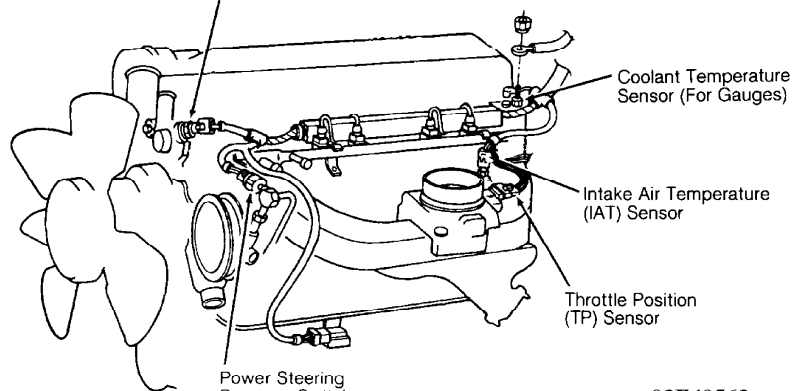
#### 4 & 6-CYLINDER

Overhead Console Ambient Temperature Sensor

On right side of lower radiator support.

Throttle Position Sensor (TPS)

Coolant Temperature Sensor (For Engine Control)



4-Cylinder

4-CYLINDER

93E49563

On throttle body assembly.



Coolant Temperature  
Sensor (For  
Engine Control)

Coolant Temperature  
Sensor (For Gauges)

Intake Air  
Temperature  
Sensor (IAT)

Power  
Steering  
Pressure  
Switch

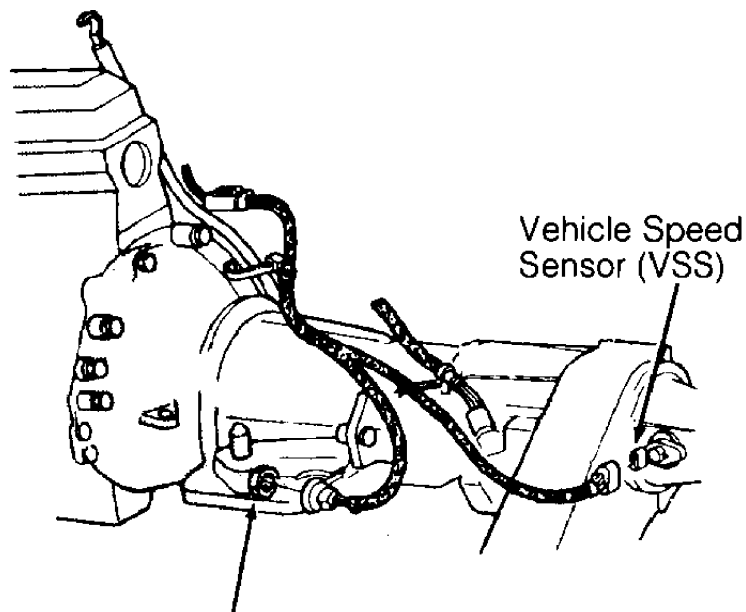
Throttle Position  
(TP) Sensor

## 6-CYLINDER

On throttle body assembly.

93G4956

6-Cylinder



Vehicle Speed  
Sensor (VSS)

Back-Up Light  
Switch

93H49566

Vehicle Speed Sensor

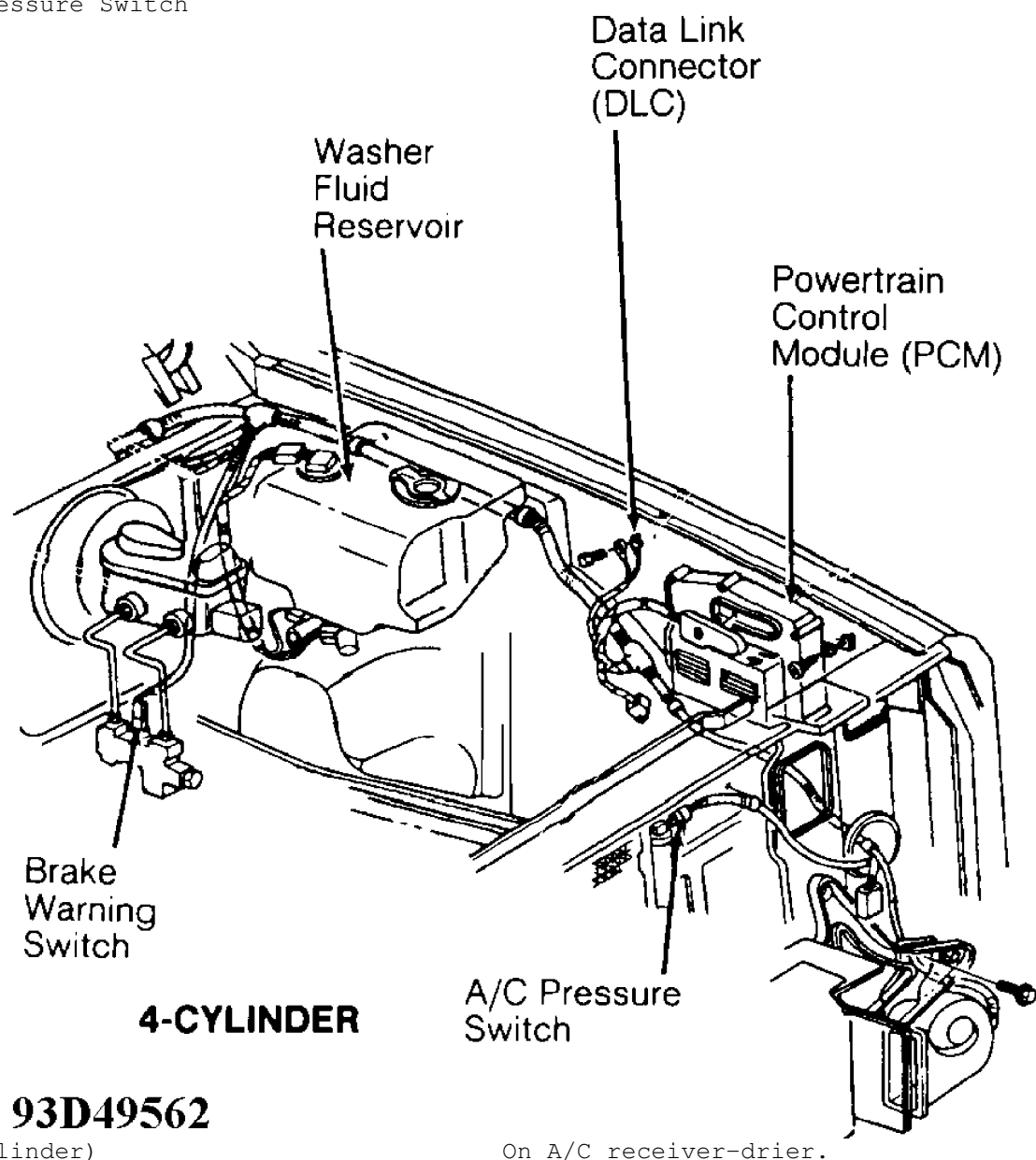
On transmission extension  
housing.

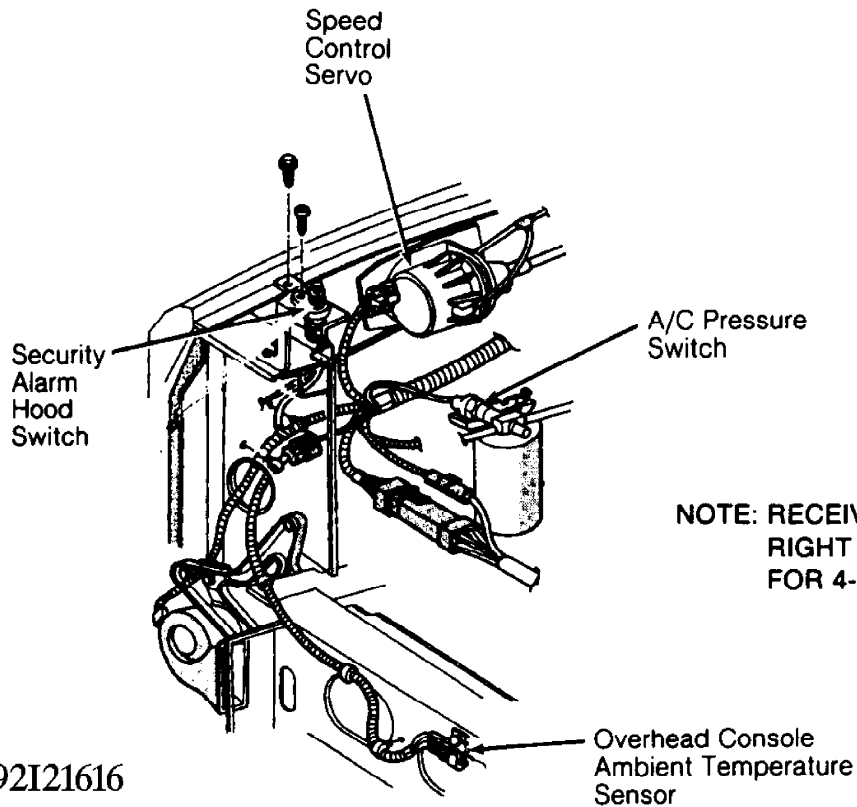
## SOLENOIDS & SOLENOID VALVES

Component	Component Location
ECAT Solenoids	On valve body, in transmission.

## SWITCHES

Component	Component Location
A/C Pressure Switch	





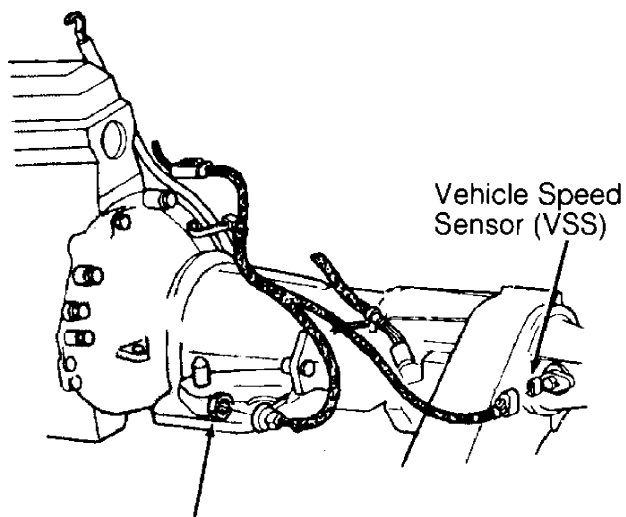
NOTE: RECEIVER/DRYER IS LOCATED IN RIGHT FRONT ENGINE COMPARTMENT FOR 4-CYLINDER.

92I21616

#### 4 & 6-CYLINDER

(4 & 6 Cylinder)

On A/C receiver-drier.

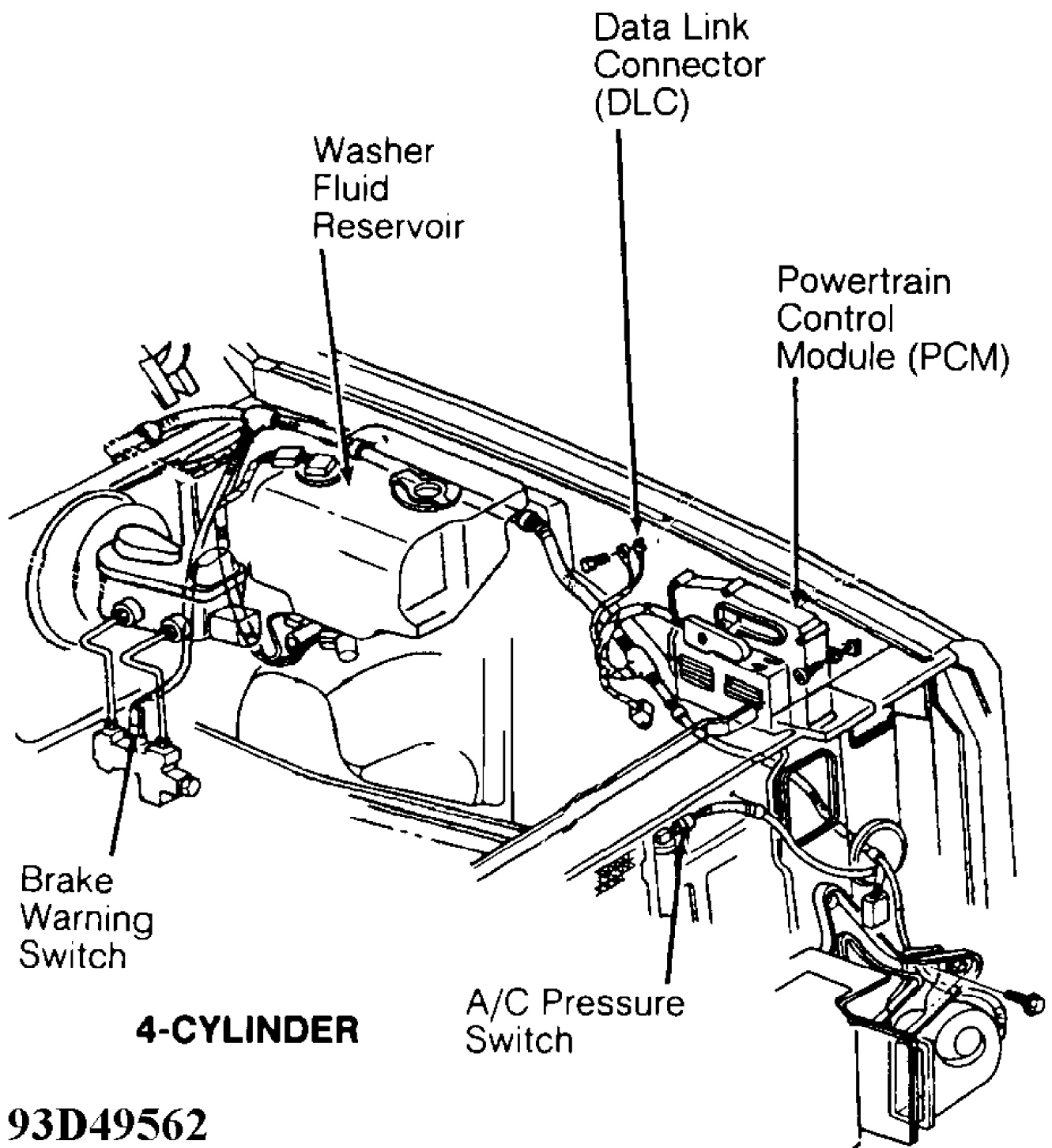


93H49566

Back-Up Light Switch

On left side of transmission case.

Brake Warning Switch

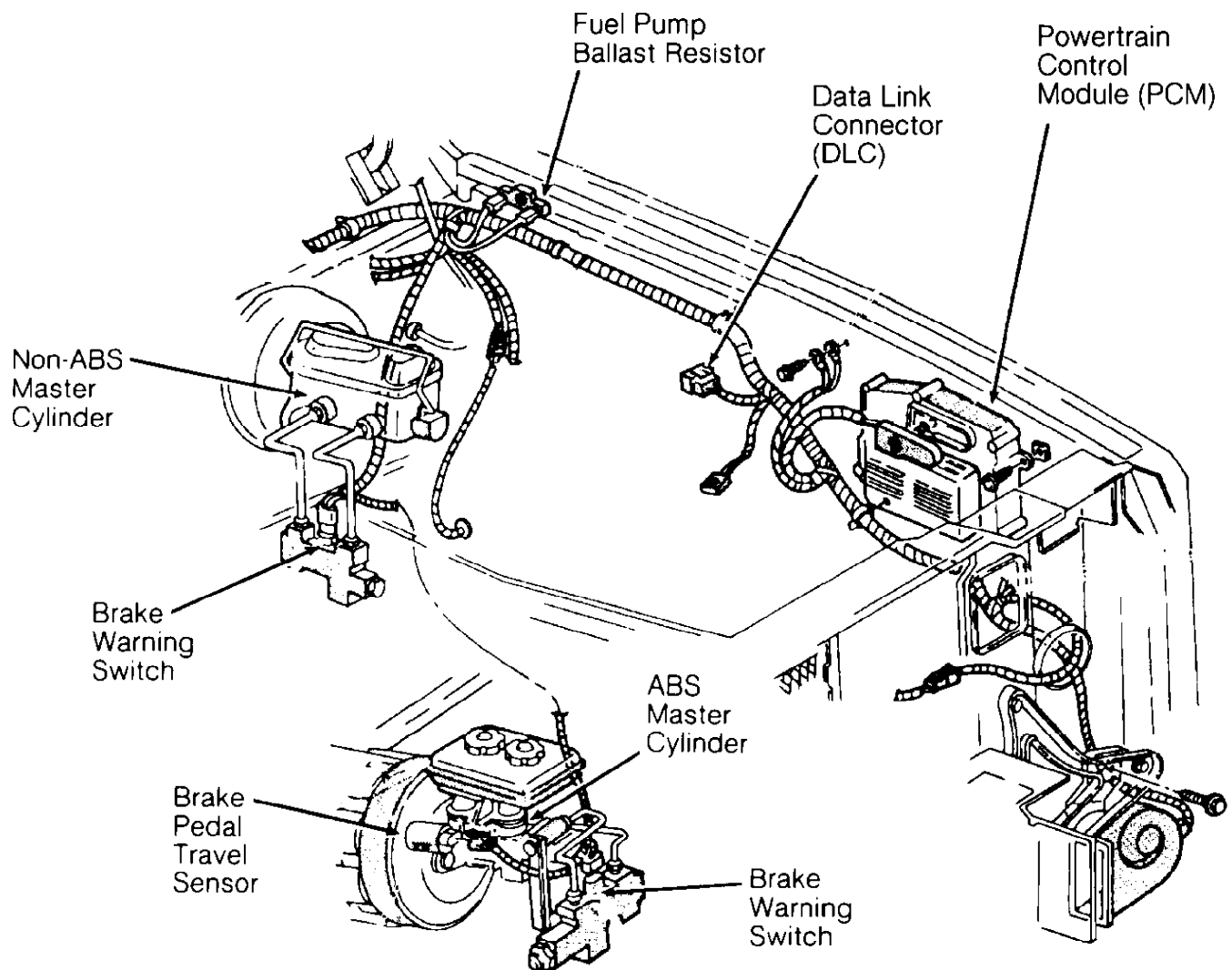


**4-CYLINDER**

**93D49562**

(4-Cylinder)

On brake pressure differential valve, below master cylinder.



**93F49564**

(6-Cylinder)

**6-CYLINDER**

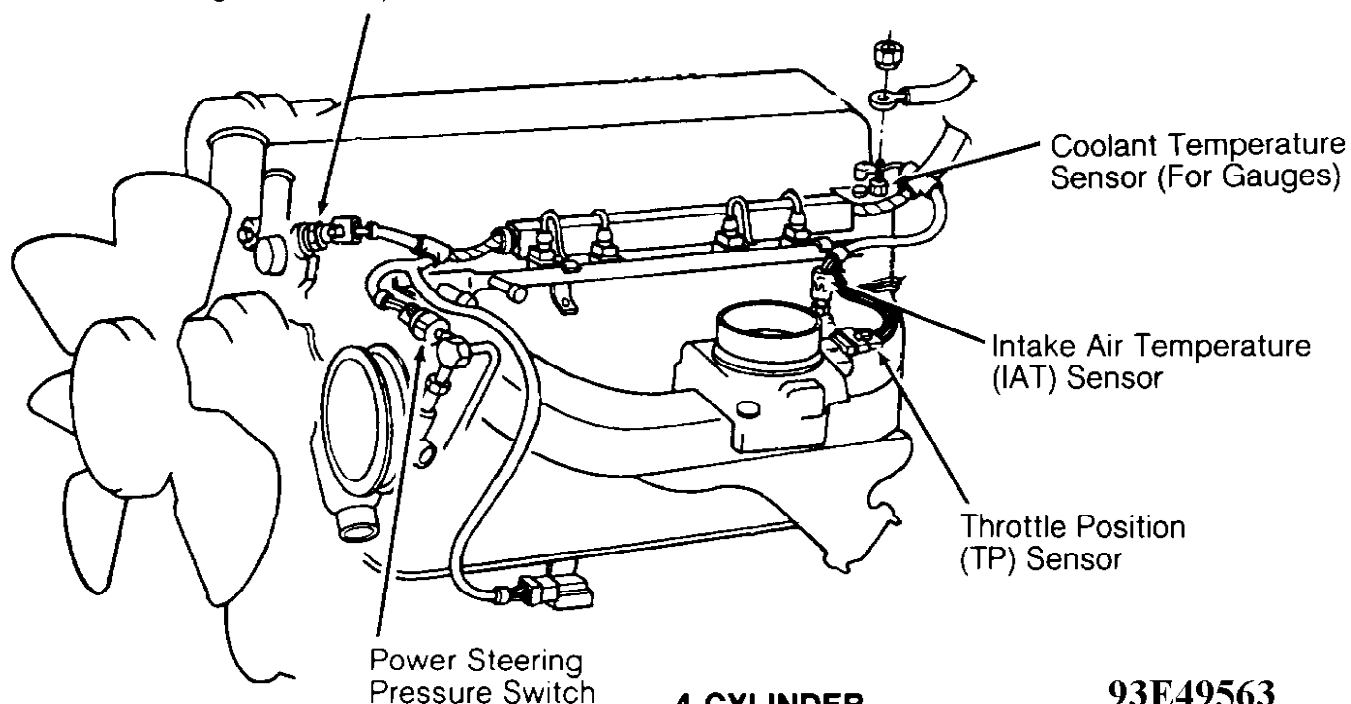
On brake pressure differential valve, below master cylinder.

Parking Brake Switch

Under center console, at base of parking brake lever.

Power Steering Pressure Switch

Coolant  
Temperature  
Sensor  
(For Engine Control)



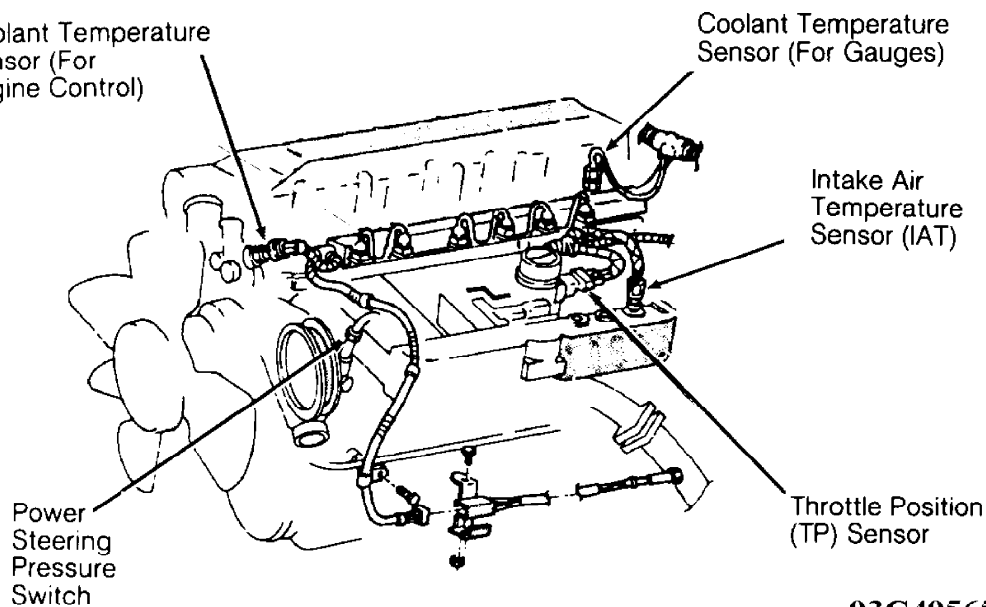
#### 4-CYLINDER

93E49563

4-Cyl

Near power steering pump, on  
high pressure hose.

Coolant Temperature  
Sensor (For  
Engine Control)



#### 6-CYLINDER

93G49565

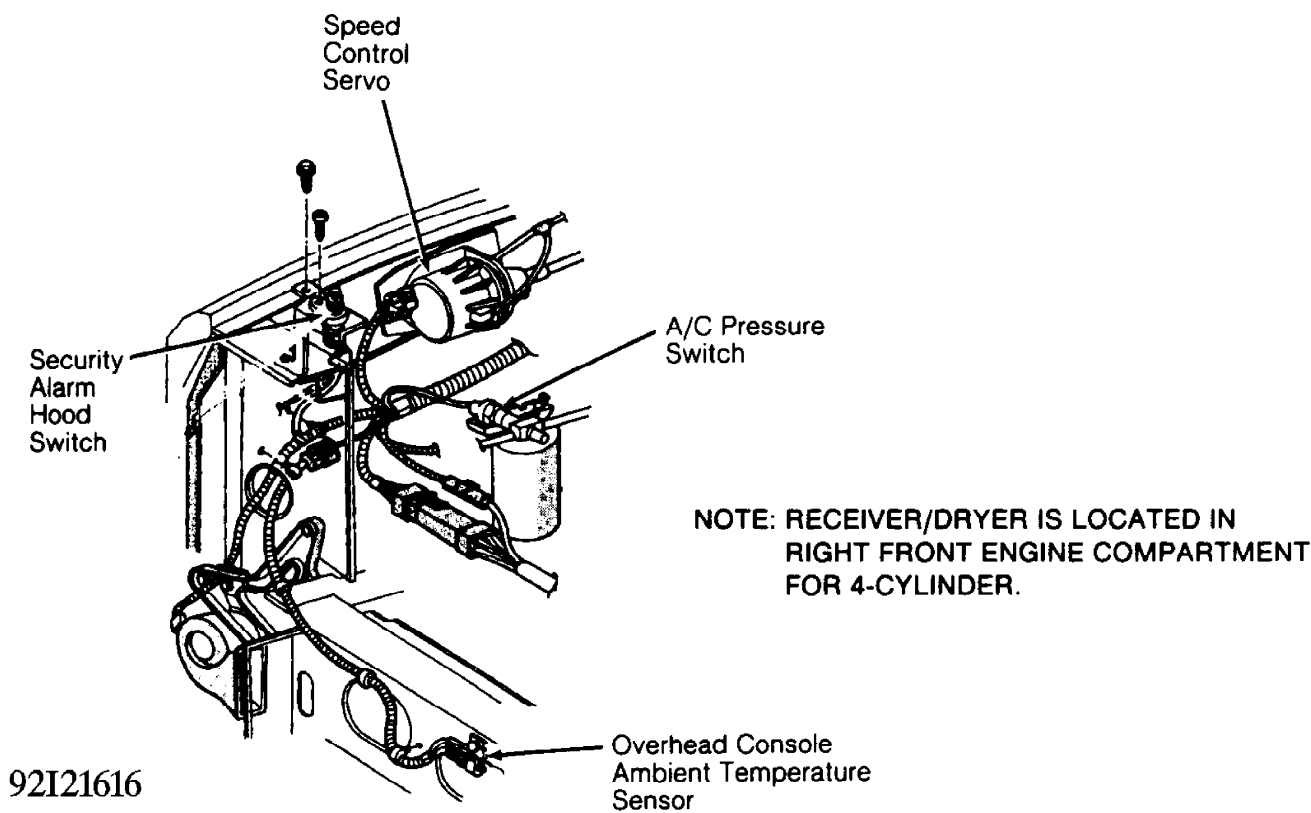
6-Cyl.

Near power steering pump, on  
high pressure hose.

Seat Belt Switch

In driver's seat belt buckle.

Security Alarm Hood Switch

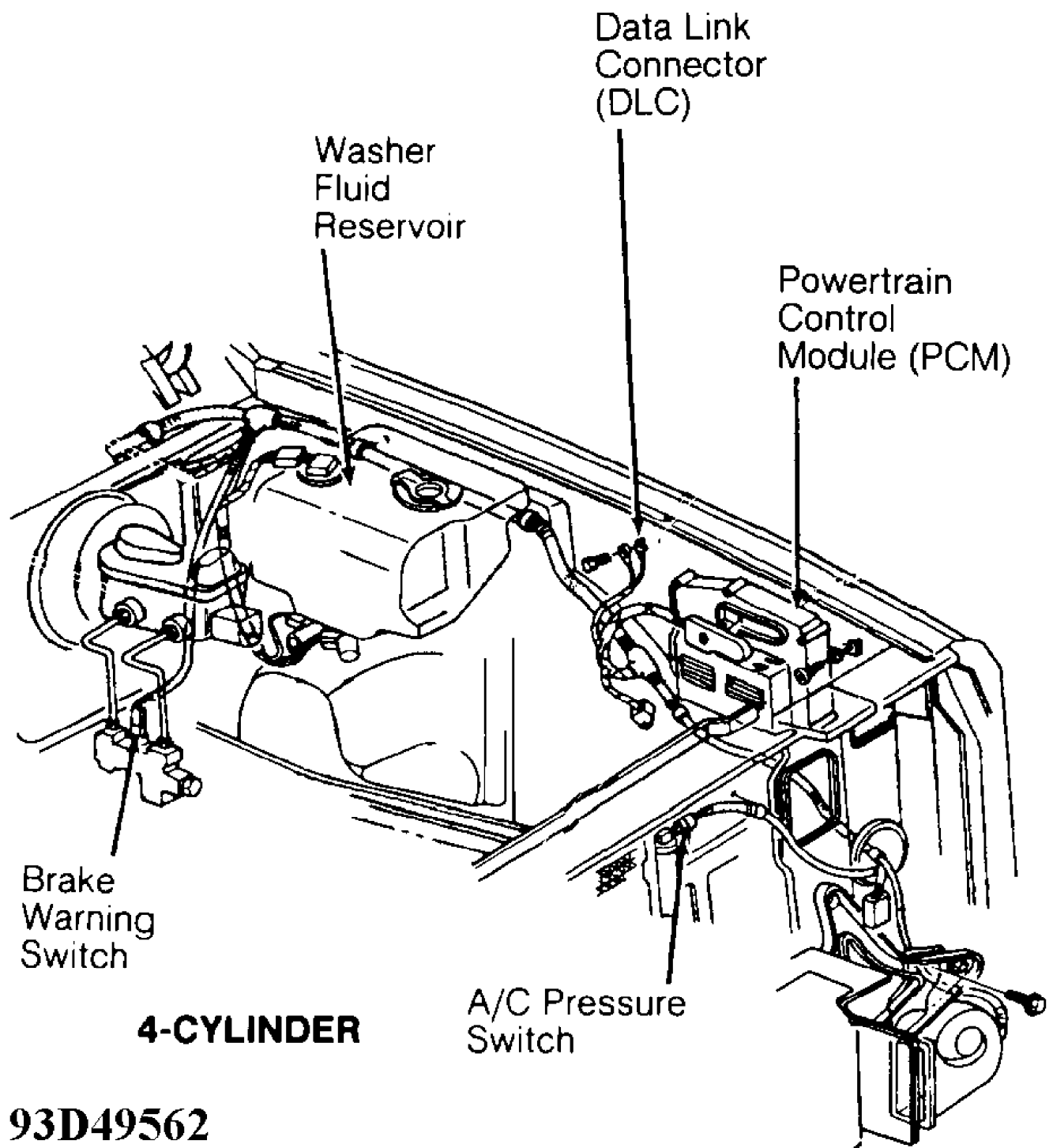


4 & 6-CYLINDER

- (4 & 6 Cylinder)
- On right front corner of engine compartment.
- 4WD Switch
- On top center of transfer case.

MISCELLANEOUS

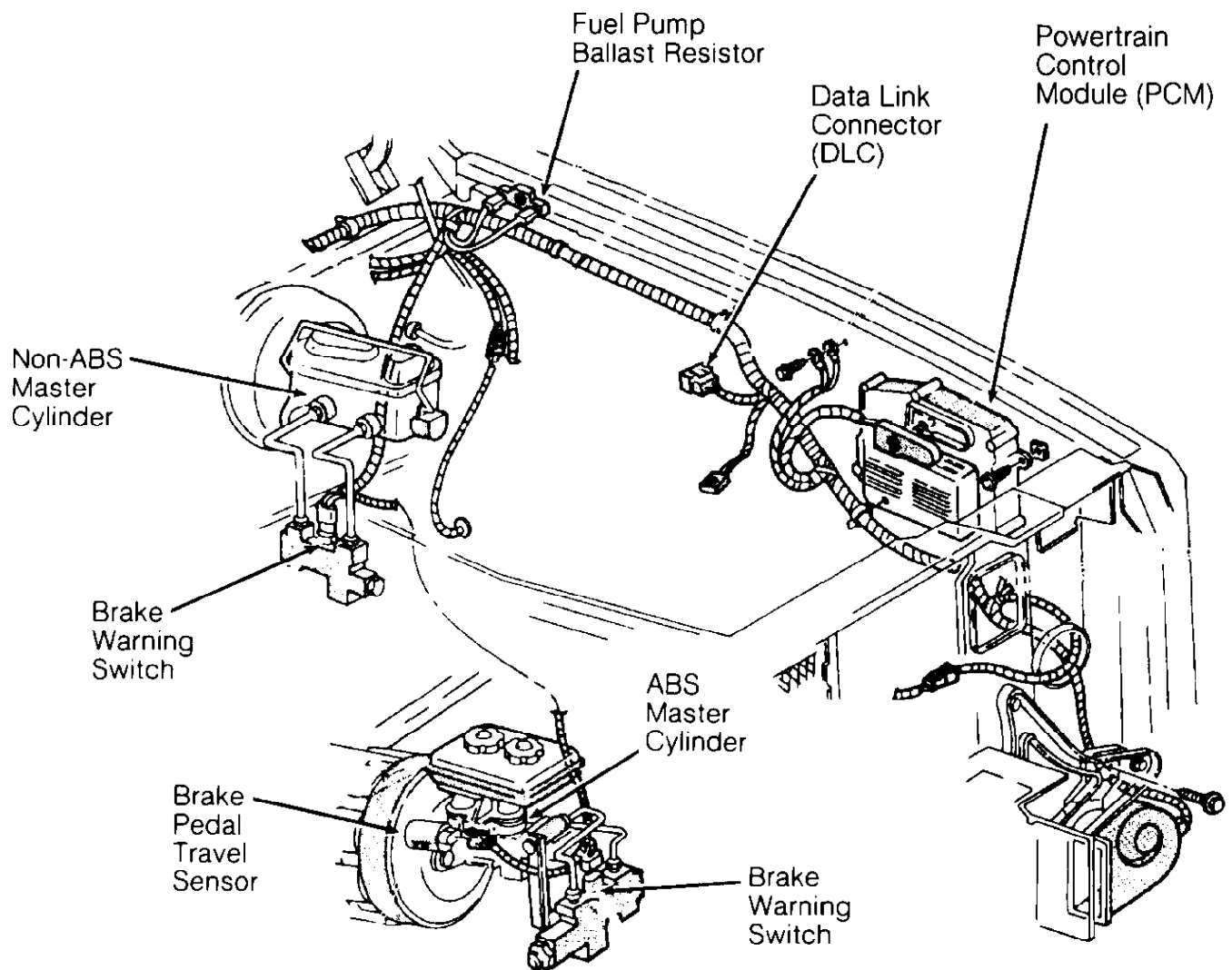
Component	Component Location
ABS Diagnostic Connector	On right front fender, behind power distribution center.
ABS Modulator	Under brake master cylinder.
A/C Clutch Diode	On A/C compressor.
A/C-Heater Blower Motor Resistor	Under right side of dash, on evaporator housing.
A/C Thermostat	Under right side of dash, on evaporator housing.
Data Link Connector (DLC)	



4-Cylinder

On left front fender apron,  
behind air cleaner.

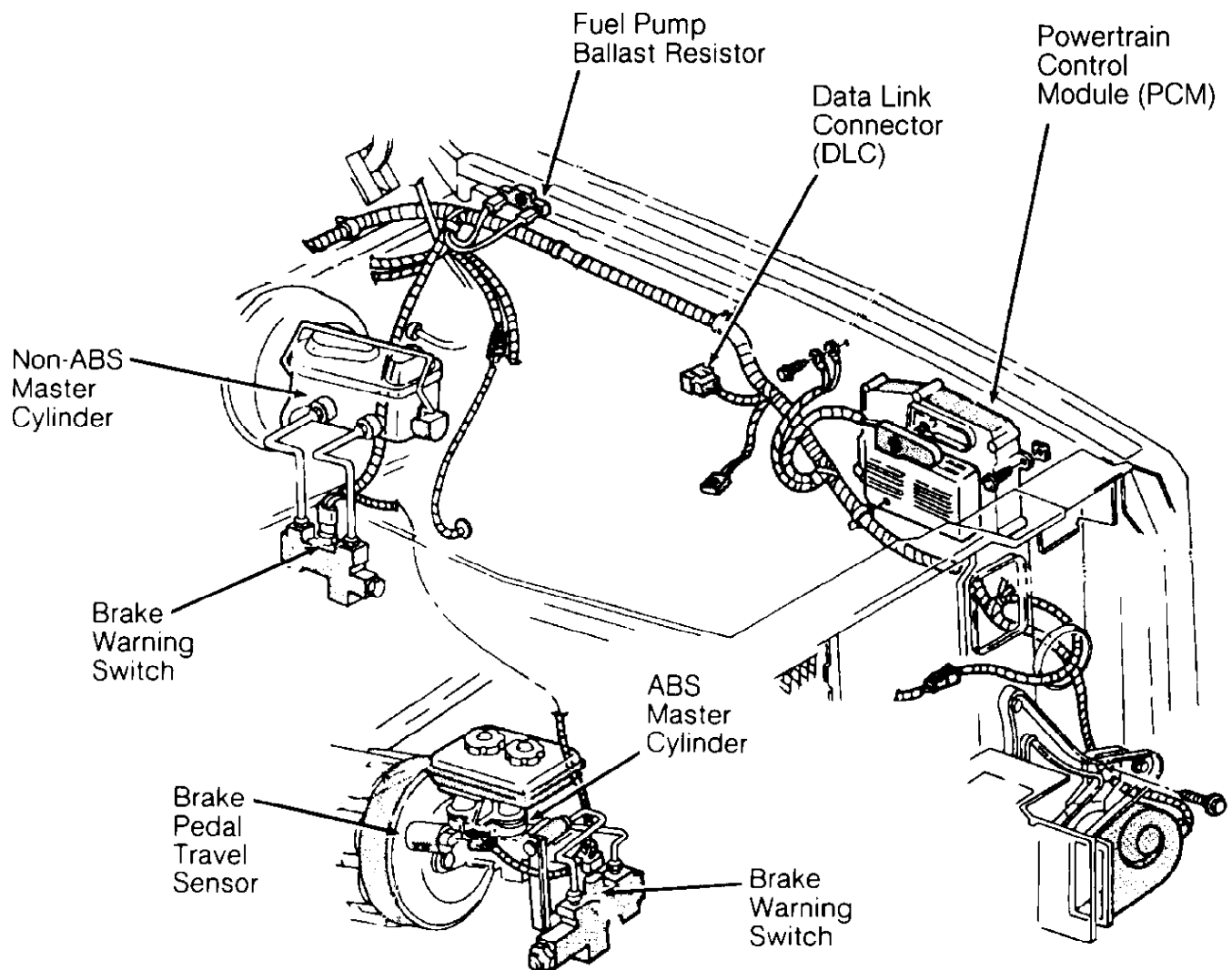




**93F49564**

6-Cylinder

**6-CYLINDER**  
On left front fender apron,  
behind air cleaner.



**93F49564**

**6-CYLINDER**

In left rear engine compartment, on inner fender panel.

Fuel Pump Ballast Resistor

# ELECTROSTATIC DISCHARGE WARNING - BASIC INFORMATION

1993 Jeep Cherokee

## GENERAL INFORMATION

Electrostatic Discharge (ESD) Warning - Basic Information

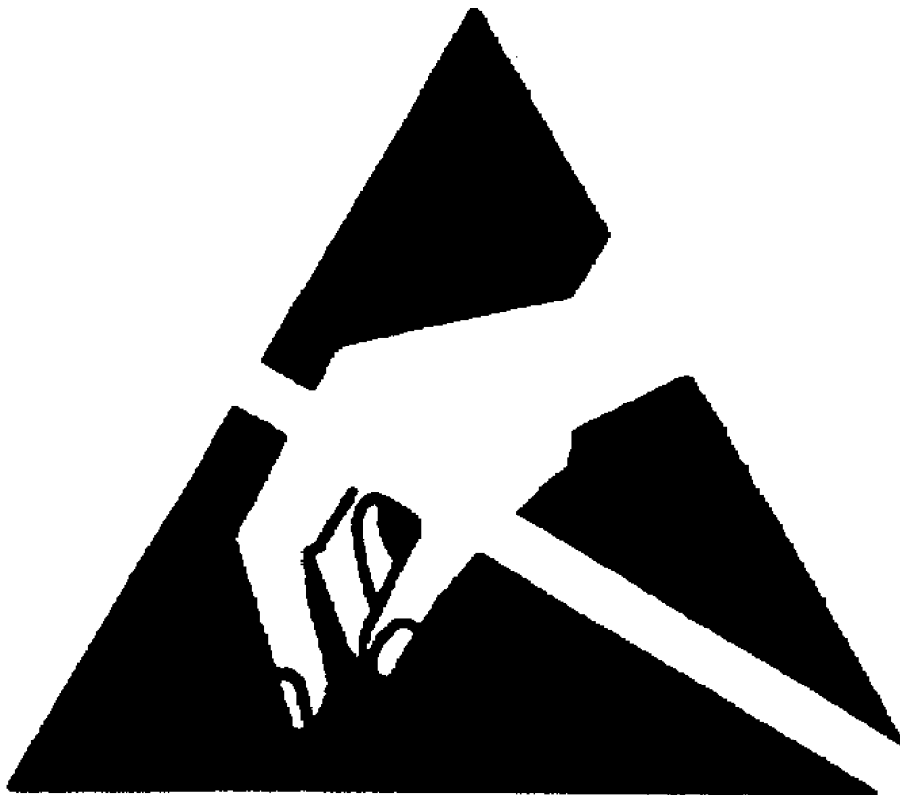
All Makes and Models

### \* PLEASE READ THIS FIRST \*

NOTE: This article is intended for general information purposes only.

## INTRODUCTION

All Electrostatic Discharge (ESD) sensitive components contain solid state circuits (transistors, diodes, semiconductors) that may become damaged when contacted with an electrostatic charge. The following information applies to all ESD sensitive devices. The ESD symbol shown in Fig. 1 may be used on schematics to indicate which components are ESD sensitive. See Fig. 1. Although different manufactures may display different symbols to represent ESD sensitive devices, the handling and measuring precautions and procedures are the same.



**5012680**

Fig. 1: Sample ESD Symbol

## HANDLING STATIC-SENSITIVE CIRCUITS/DEVICES

- 1) Always touch a known good ground source before handling the part. This should be repeated while handling the part and more frequently after sitting down from a standing position, sliding across the seat or walking a distance.
- 2) Avoid touching electrical terminals of the part, unless instructed by a diagnostic procedure.
- 3) DO NOT open the package of a new part until it is time to install the part.
- 4) Before removing the part from its package, ground the package to a known good ground source.

1) Solid State circuits in electronic devices are shown greatly simplified in schematics. See Fig. 2. Due to the simplification of the electronic devices on the schematic, resistance measurements could be misleading or could lead to an electrostatic discharge. Always follow the recommended diagnostic procedure.

- 2) Only measure resistance at the terminals of the devices when instructed by the recommended diagnostic procedure.
- 3) When using a voltmeter, be sure to connect the ground lead first.

# EMISSION CONTROL VISUAL INSPECTION PROCEDURES

1993 Jeep Cherokee

1983-98 GENERAL INFORMATION  
Emission Control Visual Inspection Procedures

All Models

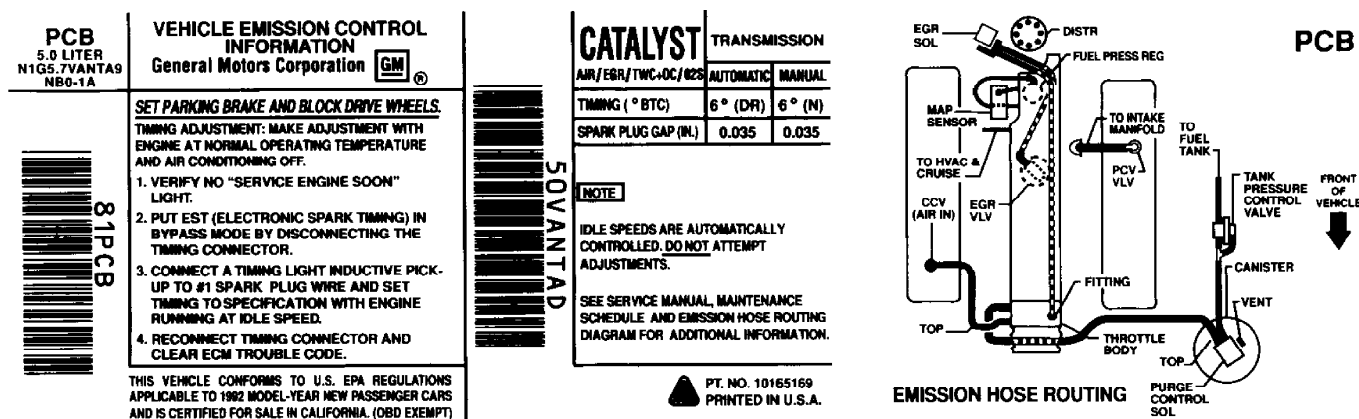
## \* PLEASE READ THIS FIRST \*

This article is provided for general information only. Not all information applies to all makes and models. For more complete information, see appropriate article(s) in the ENGINE PERFORMANCE Section.

## EMISSION CONTROL LABELS

The vehicle manufacturer's emission control label, also known as the underhood tune-up label or Vehicle's Underhood Emission Control System (VECI) label, is located in the engine compartment. Information regarding year model of vehicle, engine size, number of cylinders, emission equipment or type, engine tune-up specifications, whether vehicle was manufactured for sale in California or is a Federal vehicle, vacuum hose routing schematic, etc., can be found on this label. See Fig. 1.

In addition to the VECI label, some emission control inspection and maintenance programs may require an additional label to be affixed to the vehicle in special circumstances. For example, in California, a Bureau Of Automotive Repair (BAR) engine label may be affixed to the left door post. A BAR engine label is only used when the vehicle has an engine change, approved modification or is a Specially Constructed (SPCN) or an acceptable Gray market vehicle. Check your state's emission control inspection and maintenance laws to determine if a similar label is used.



93D04127

Fig. 1: Typical Emission Control Label  
Courtesy of General Motors Corp.

## EMISSION CONTROL VISUAL INSPECTION

### \* PLEASE READ THIS FIRST \*

**NOTE:** The following emission control visual inspection procedures should be used as a guide only. When performing a visual inspection, always follow your state's recommended

inspection procedures.

A visual inspection is made to determine if any required emission control devices are missing, modified or disconnected. Missing, modified or disconnected systems must be made fully operational before a vehicle can be certified.

## POSITIVE CRANKCASE VENTILATION (PCV)

PCV controls the flow of crankcase fumes into the intake manifold while preventing gases and flames from traveling in the opposite direction. PCV is either an open or closed system. See Fig. 2

Ensure PCV system is installed as required. Verify valve, required hoses, connections, flame arresters, etc., are present, routed properly and in serviceable condition.

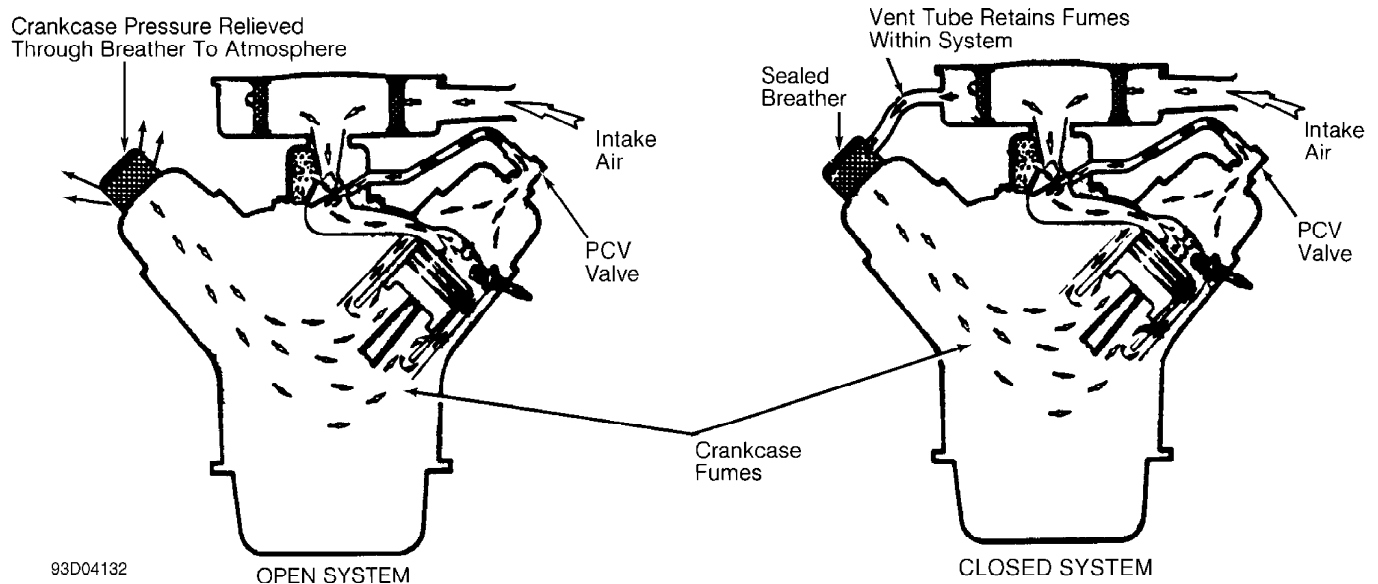
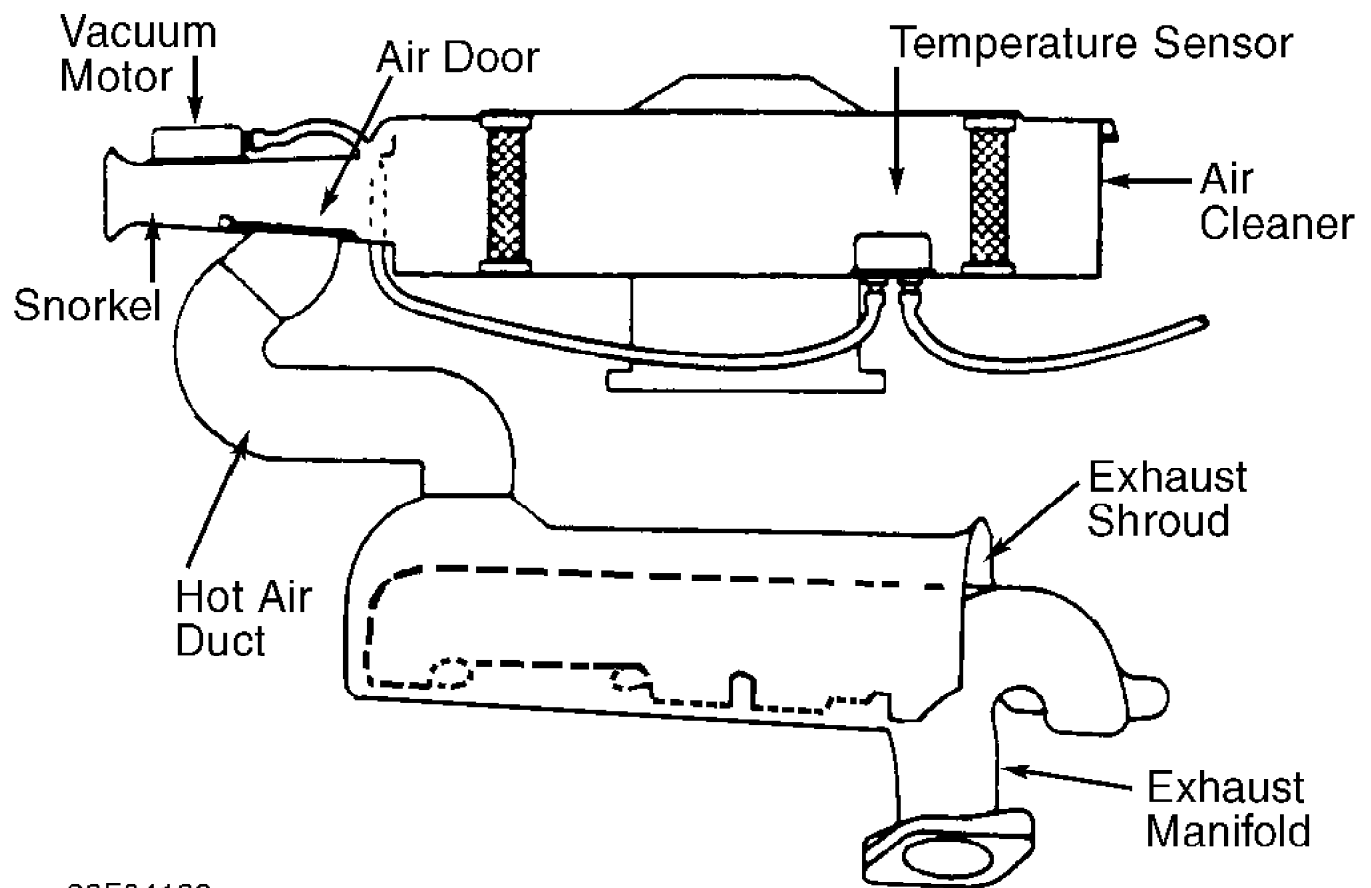


Fig. 2: Typical Open & Closed Type PCV System

## THERMOSTATIC AIR CLEANER (TAC)

The TAC supplies warm air to air intake during cold engine operation. This system is active during cold engine warm-up only. Under all other operating conditions, air cleaner function is the same as any non-thermostatic unit.

Ensure required exhaust shroud, hot air duct, vacuum hoses and air cleaner components are present and installed properly. See Fig. 3. Ensure any required thermostatic vacuum switches are in place and vacuum hoses are installed and in serviceable condition. Also ensure air cleaner lid is installed right side up. Check for oversized air filter elements and for additional holes in the air cleaner housing.



93F04133

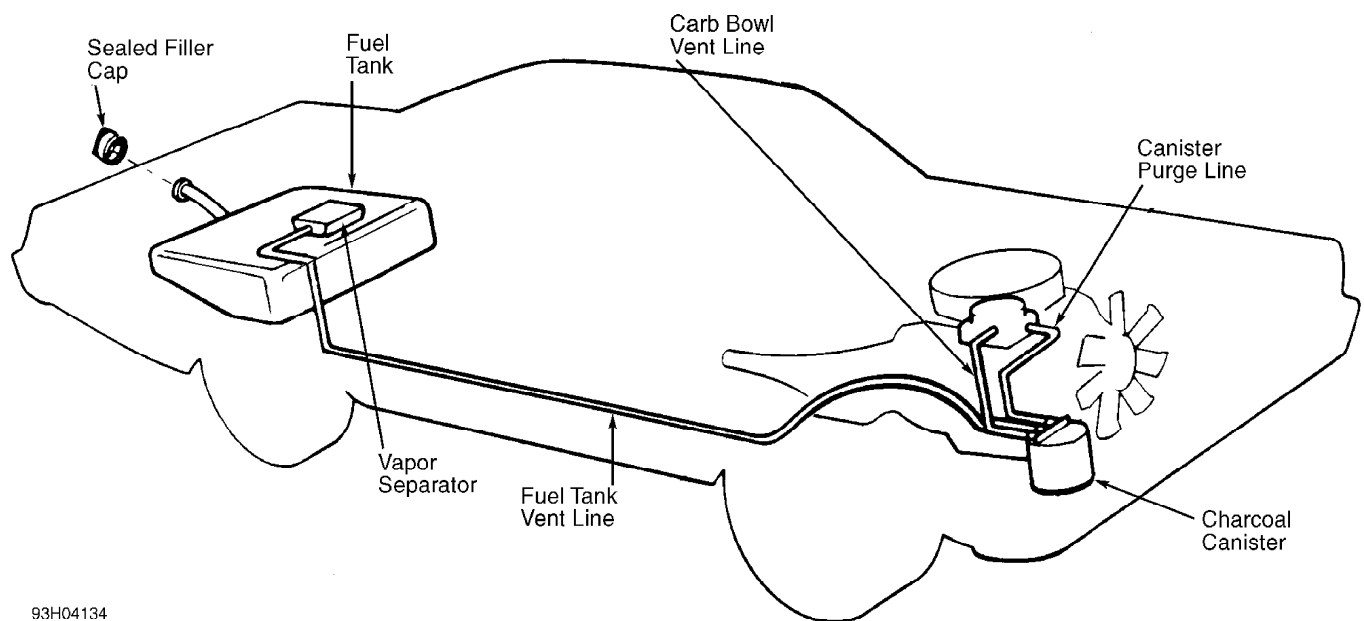
Fig. 3: Typical Thermostatic Air Cleaner System

### FUEL EVAPORATIVE SYSTEM (EVAP)

The EVAP system allows for proper fuel system ventilation while preventing fuel vapors from reaching the atmosphere. This means that vapors must be caught and stored while the engine is off, which is when most fuel evaporation occurs. When the engine is started, these fuel vapors can be removed from storage and burned. In most systems, storage is provided by an activated charcoal (or carbon) canister. See Fig. 4. On a few early systems, charcoal canisters are not used. Instead, fuel vapors are vented into the PCV system and stored inside the crankcase.

The main components of a fuel evaporation system are a sealed fuel tank, a liquid-vapor separator and vent lines to a vapor-storing canister filled with activated charcoal. The filler cap is normally not vented to the atmosphere, but is fitted with a valve to allow both pressure and vacuum relief.

Although a few variations do exist between manufacturers, basic operation is the same for all systems. Check for presence of vapor storage canister or crankcase storage connections when required. Ensure required hoses, solenoids, etc., are present and connected properly. Check for proper type fuel tank cap. Check for any non-OEM or auxiliary fuel tanks for compliance and the required number of evaporation canisters.



93H04134

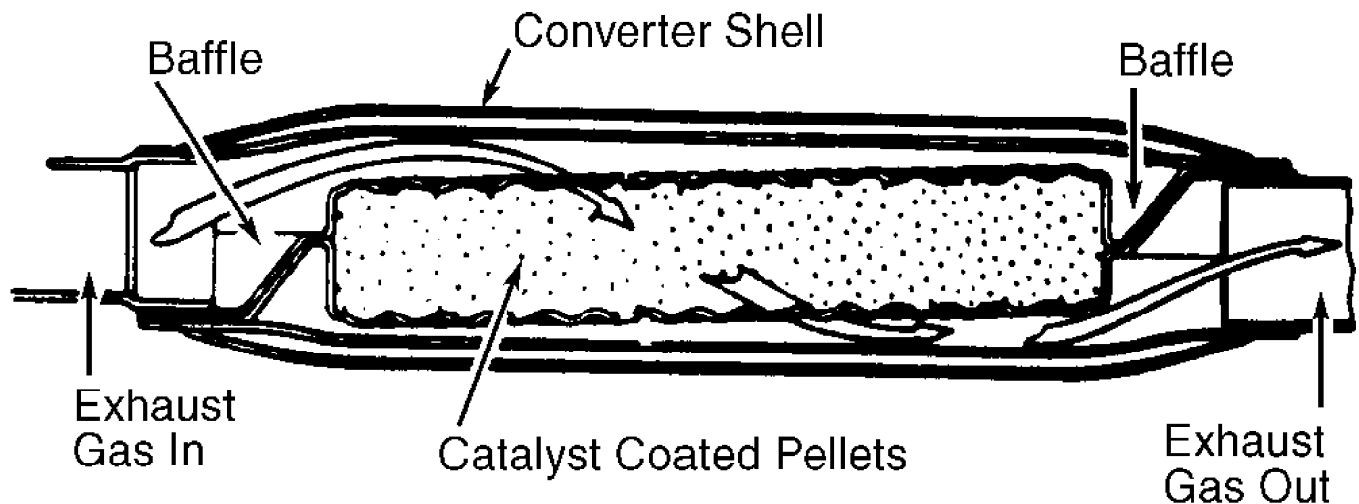
Fig. 4: Typical Fuel Evaporative System

## CATALYTIC CONVERTERS

### Oxidation Catalyst (OC)

This type of converter is the most common. It may use pellets or monolith medium, depending upon application. See Fig. 5. Platinum and palladium (or platinum alone) are used as catalyst in this type of converter.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Also check for pellets or pieces of converter in the tailpipe.



93A04135

Fig. 5: Typical Oxidation Catalytic Converter (Pellet Type) Shown; Typical Three-Way Catalytic Converter Is Similar  
Courtesy of General Motors Corp.

### Three-Way Catalyst (TWC)

This type of converter is nearly identical to a conventional



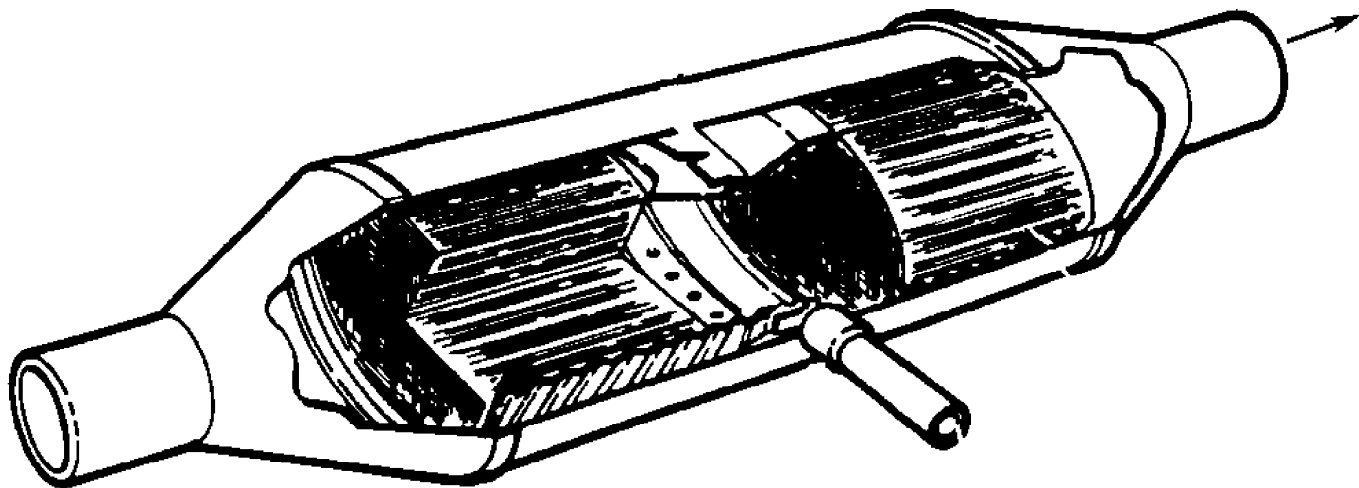
converter with the exception of the catalyst. See Fig. 5. The TWC converter uses rhodium, with or without platinum, as its catalyst. Rhodium helps reduce NO<sub>x</sub> emissions, as well as HC and CO.

Visually check for presence of catalytic converter(s). Also check for presence of any required air supply system for the oxidizing section of the converter. Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.

#### Three-Way Catalyst + Oxidation Catalyst (TWC + OC)

This system contains a TWC converter and an OC converter in a common housing, separated by a small air space. See Fig. 6. The 2 catalysts are referred to as catalyst beds. Exhaust gases pass through the TWC first. The TWC bed performs the same function as it would as a separate device, reducing all 3 emissions. As exhaust gases leave the bed, they pass through the air space and into the second (OC) converter catalyst bed.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.



93C04136

Fig. 6: Typical Three-Way + Oxidation Catalytic Converter  
Courtesy of General Motors Corp.

#### FILL PIPE RESTRICTOR (FR)

A fuel tank fill pipe restrictor is used to prohibit the introduction of leaded fuel into the fuel tank. Unleaded gasoline pump dispensers have a smaller diameter nozzle to fit fuel tank of vehicle requiring the use of unleaded fuel (vehicles equipped with catalytic converter).

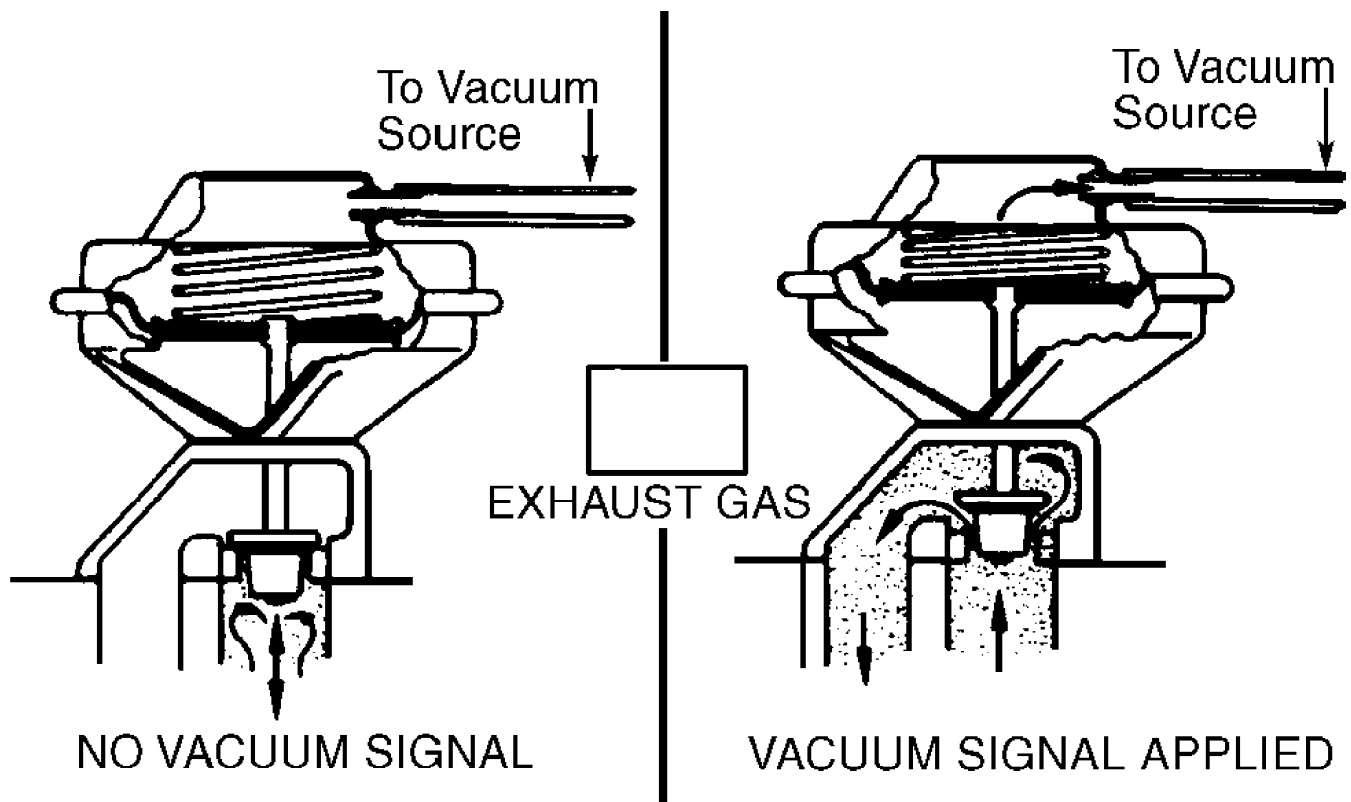
Visually inspect fill pipe restrictor(s) for tampering, i.e., restrictor is oversize or the flapper is non-functional. If vehicle is equipped with an auxiliary fuel tank, ensure auxiliary fuel tank is also equipped with a fill pipe restrictor.

#### EXHAUST GAS RECIRCULATION (EGR) SYSTEM

#### Single Diaphragm EGR Valve

This type uses a single diaphragm connected to the valve by a shaft. Diaphragm is spring-loaded to keep valve closed in the absence of vacuum. As throttle valves open and engine speed increases, vacuum is applied to the EGR vacuum diaphragm, opening the EGR valve. This vacuum signal comes from a ported vacuum source. Variations in the vacuum signal control the amount of exhaust gas that is recirculated. See Fig. 7.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.



93E04137

Fig. 7: Typical Single Diaphragm EGR Valve  
Courtesy of General Motors Corp.

#### Dual Diaphragm EGR Valve

This type uses 2 diaphragms with different effective areas and 2 vacuum sources. Although similar to the single diaphragm type, the second diaphragm is added below the upper diaphragm and is rigidly attached to the valve seat. See Fig. 8. These diaphragms form a vacuum chamber which is connected to manifold vacuum.

During highway cruising when manifold vacuum is high in the center chamber, manifold vacuum tends to pull the valve closed. However, the vacuum signal applied to the top side of the upper diaphragm overcomes the downward spring force and the manifold vacuum pull, due to the diaphragm's larger piston. This regulates the amount of EGR.

When manifold vacuum is low during acceleration, the higher vacuum signal opens the valve, permitting more EGR. When manifold vacuum is high during highway cruising, the valve is only partially opened, reducing the amount of EGR.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

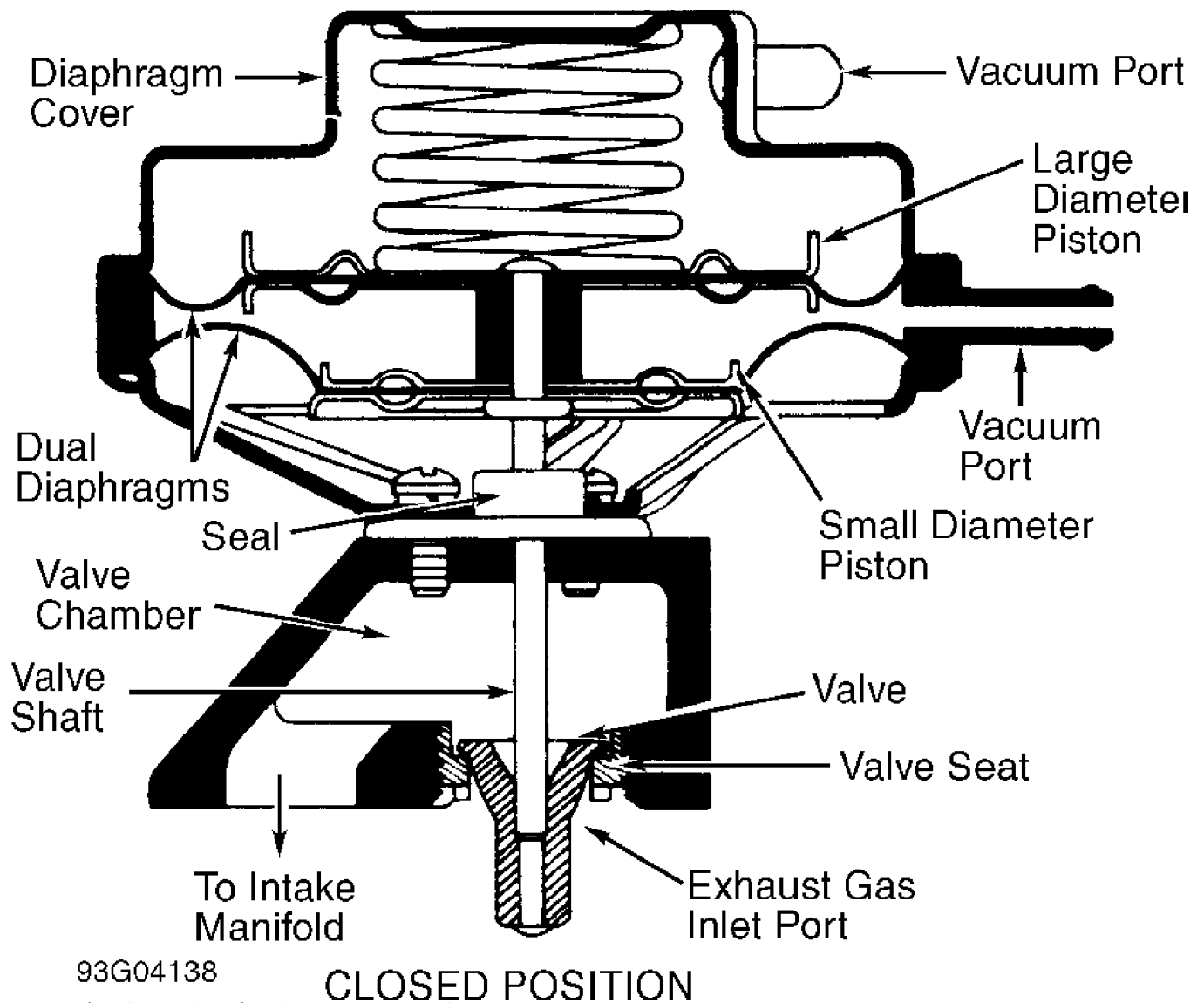


Fig. 8: Typical Dual Diaphragm EGR Valve  
Courtesy of General Motors Corp.

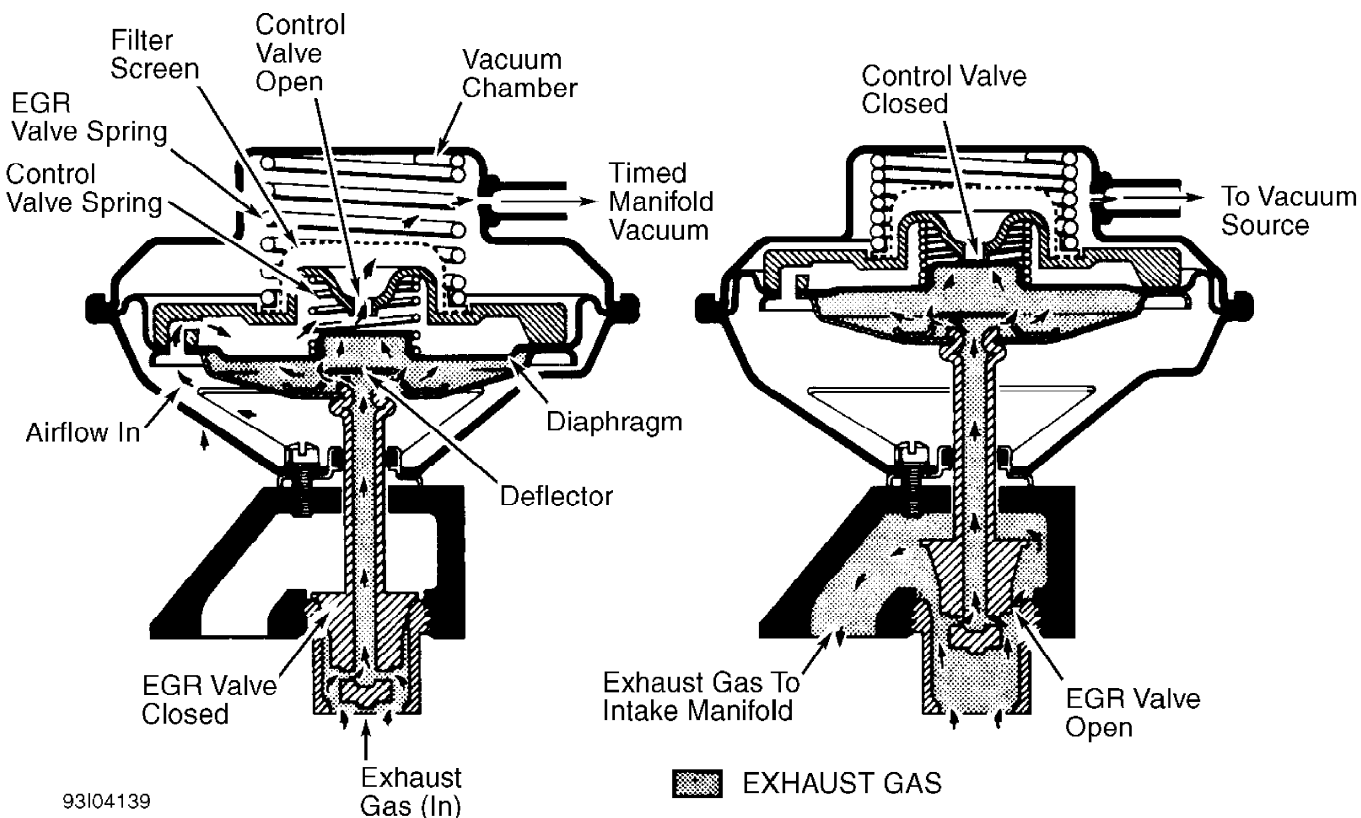
#### Positive Backpressure EGR (BP/EGR) Valve

This type uses both engine vacuum and exhaust backpressure to control the amount of EGR. It provides more recirculation during heavy engine loads than the single diaphragm EGR valve.

A small diaphragm-controlled valve inside EGR valve acts as a pressure regulator. The control valve gets an exhaust backpressure signal through the hollow valve shaft. This exhaust backpressure exerts a force on bottom of control valve diaphragm. The diaphragm plate contains 6 bleed holes to bleed air into the vacuum chamber when backpressure valve is in open position. See Fig. 9.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed

switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.



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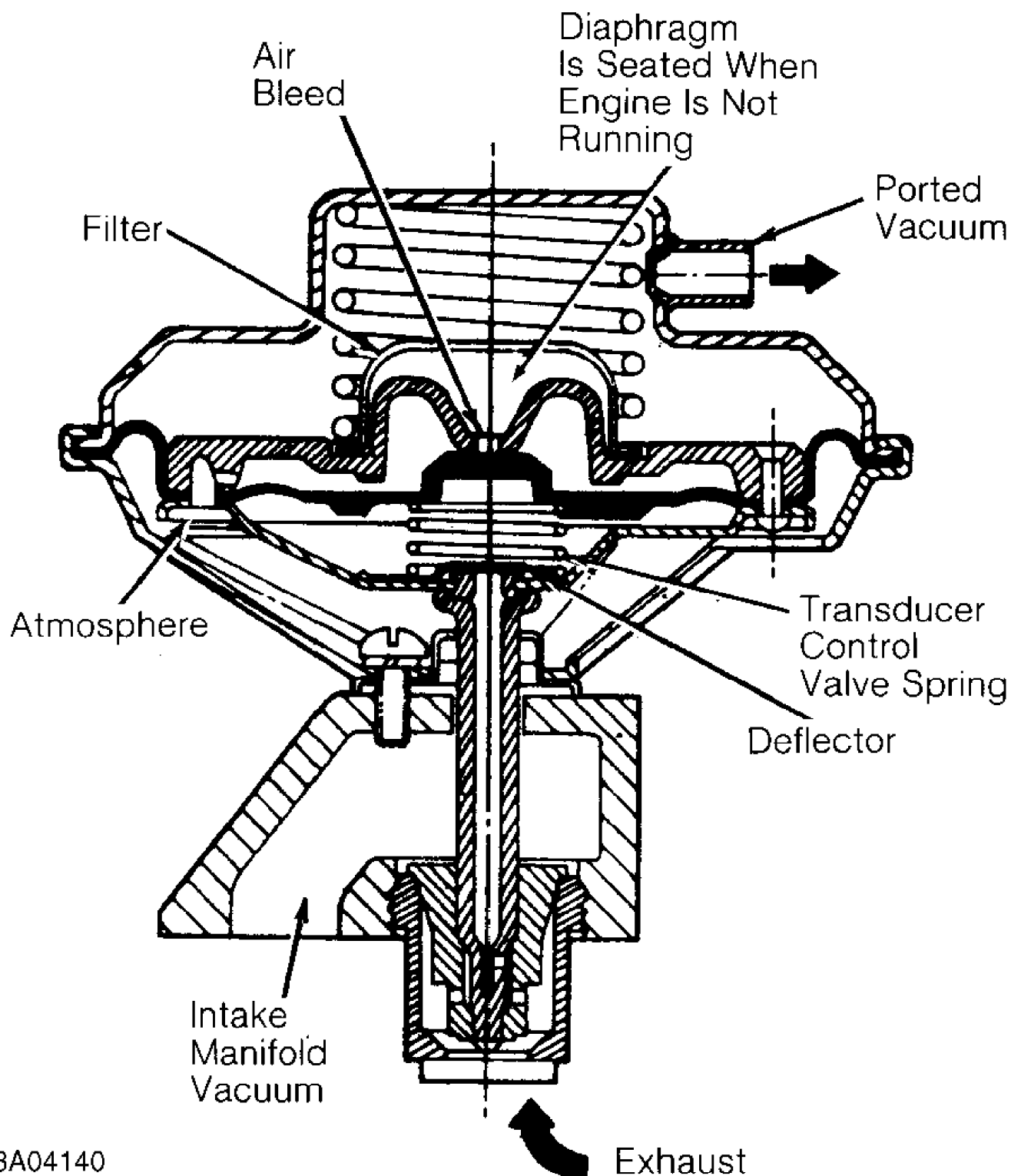
Fig. 9: Typical Positive Backpressure EGR Valve  
Courtesy of General Motors Corp.

#### Negative Backpressure EGR (BP/EGR) Valve

This type has the same function as the positive BP/EGR valve except valve is designed to open with a negative exhaust backpressure. The control valve spring in the transducer is placed on the bottom side of the diaphragm. See Fig. 10.

When ported vacuum is applied to the main vacuum chamber, partially opening the valve, the vacuum signal from the manifold side (reduced by exhaust backpressure) is transmitted to the hollow stem of the valve. See Fig. 10. This enables the signal to act on the diaphragm, providing a specific flow. Thus, the EGR flow is a constant percentage of engine airflow.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.



93A04140

Fig. 10: Typical Negative Backpressure EGR Valve  
Courtesy of General Motors Corp.

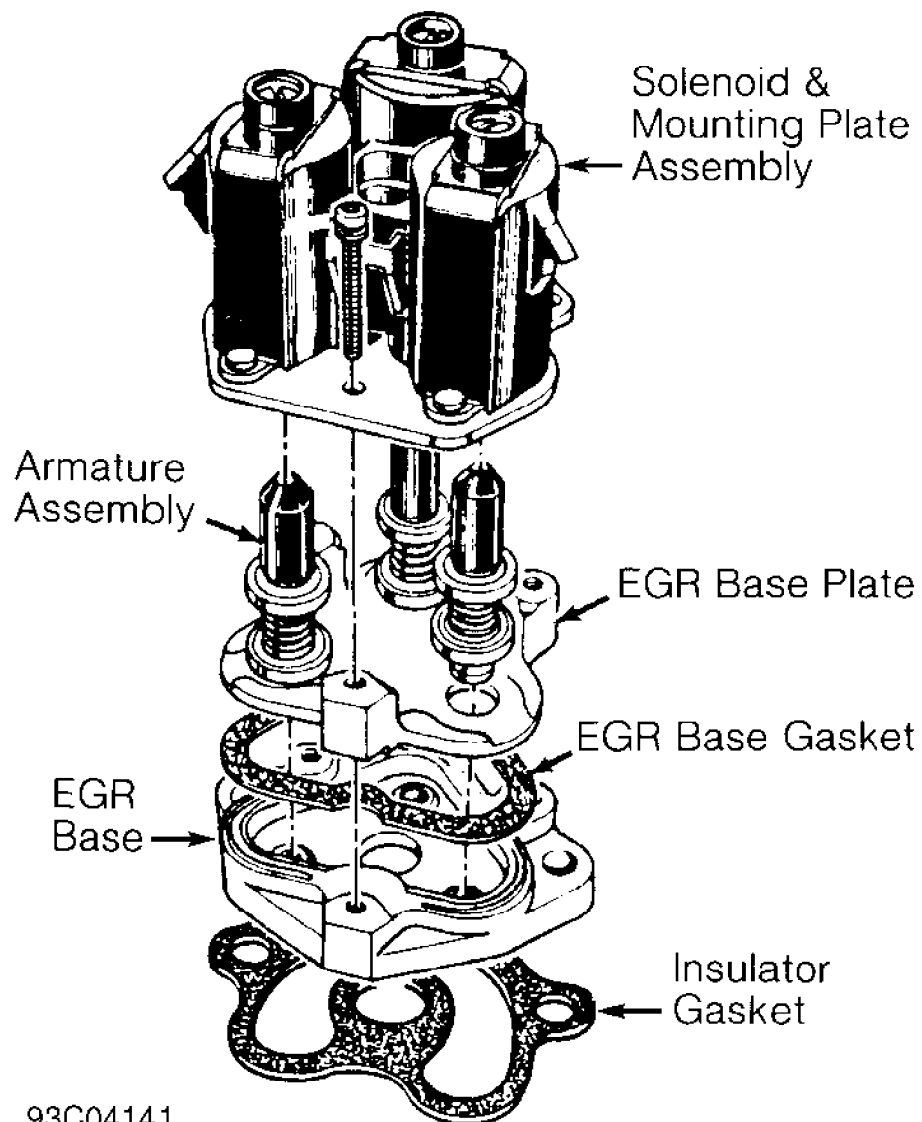
#### Digital EGR Valve

The digital EGR valve operates independently of engine manifold vacuum. This valve controls EGR flow through 3 orifices.

These 3 orifices are opened and closed by electric solenoids. The solenoids are, in turn, controlled by the Electronic Control Module (ECM). When a solenoid is energized, the armature with attached shaft and swivel pintle is lifted, opening the orifice. See Fig. 11.

The ECM uses inputs from the Coolant Temperature Sensor (CTS), Throttle Position Sensor (TPS) and Mass Airflow (MAF) sensors to control the EGR orifices to make 7 different combinations for precise EGR flow control. At idle, the EGR valve allows a very small amount of exhaust gas to enter the intake manifold. This EGR valve normally operates above idle speed during warm engine operation.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged. Ensure electrical connector to EGR valve is not disconnected.



93C04141

Fig. 11: Typical Digital EGR Valve  
Courtesy of General Motors Corp.

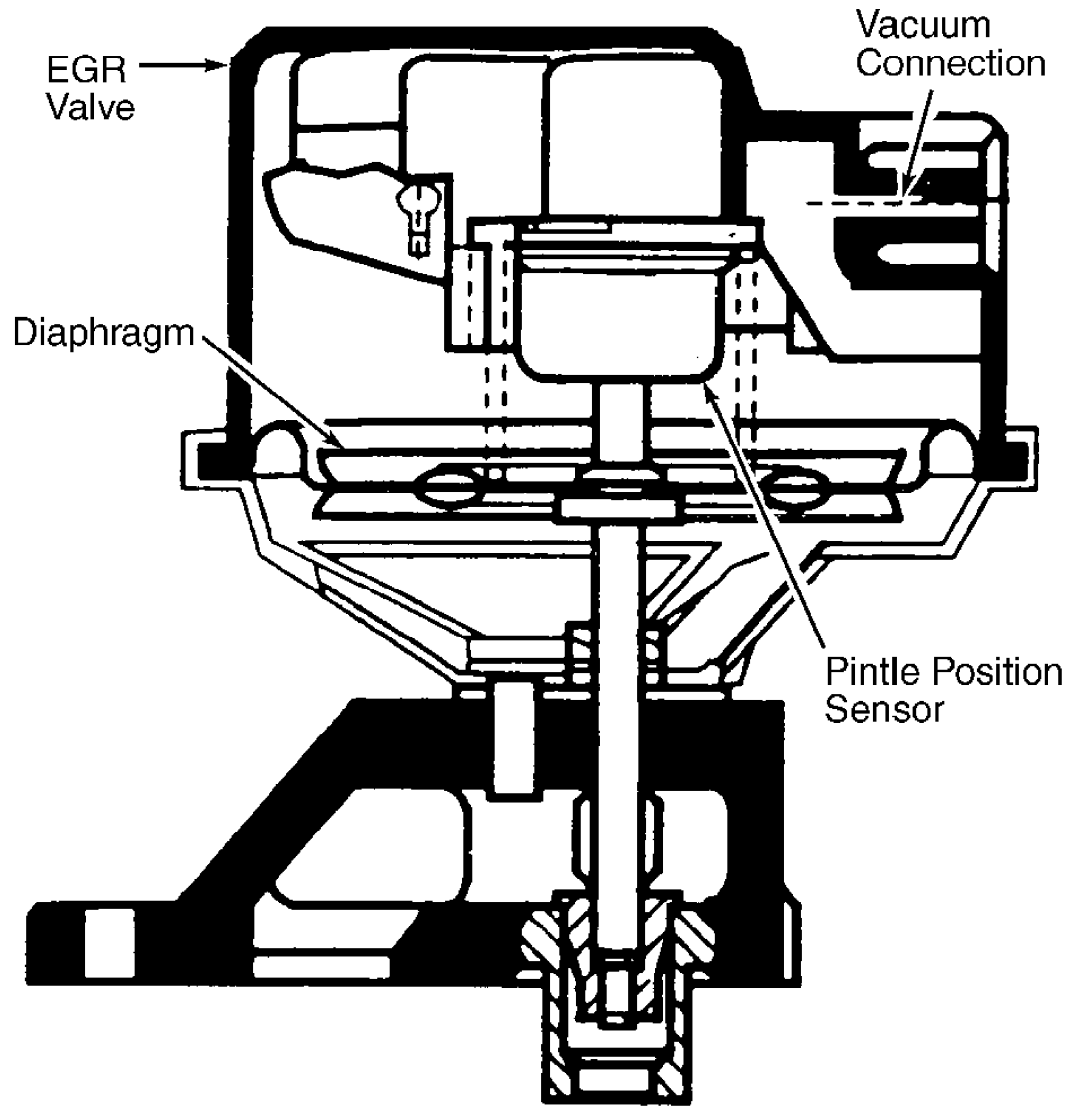
Integrated Electronic EGR Valve

This type functions similar to a ported EGR valve with a

remote vacuum regulator. The internal solenoid is normally open, which causes the vacuum signal to be vented off to the atmosphere when EGR is not controlled by the Electronic Control Module (ECM). The solenoid valve opens and closes the vacuum signal, controlling the amount of vacuum applied to the diaphragm. See Fig. 12.

The electronic EGR valve contains a voltage regulator, which converts ECM signal and regulates current to the solenoid. The ECM controls EGR flow with a pulse width modulated signal based on airflow, TPS and RPM. This system also contains a pintle position sensor, which works similarly to a TPS sensor. As EGR flow is increased, the sensor output increases.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure electrical connector to EGR valve is not disconnected.



93E04142

Fig. 12: Cutaway View Of Typical Integrated Electronic EGR Valve  
Courtesy of General Motors Corp.

SPARK CONTROLS (SPK)

Spark control systems are designed to ensure the air/fuel mixture is ignited at the best possible moment to provide optimum efficiency and power and cleaner emissions.

Ensure vacuum hoses to the distributor, carburetor, spark delay valves, thermal vacuum switches, etc., are in place and routed properly. On Computerized Engine Controls (CEC), check for presence of required sensors (O<sub>2</sub>, MAP, CTS, TPS, etc.). Ensure they have not been tampered with or modified.

Check for visible modification or replacement of the feedback carburetor, fuel injection unit or injector(s) with a non-feedback carburetor or fuel injection system. Check for modified emission-related components unacceptable for use on pollution-controlled vehicles.

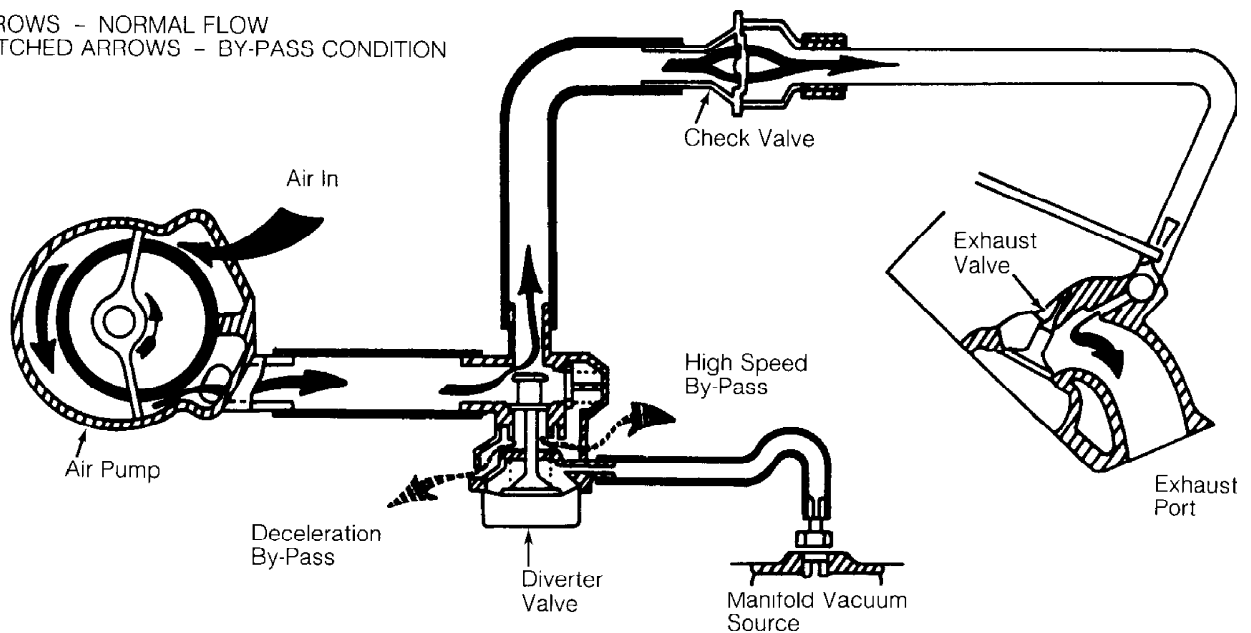
## AIR INJECTION SYSTEM (AIS)

### Air Pump Injection System (AP)

The air pump is a belt-driven vane type pump, mounted to engine in combination with other accessories. The air pump itself consists of the pump housing, an inner air cavity, a rotor and a vane assembly. As the vanes turn in the housing, filtered air is drawn in through the intake port and pushed out through the exhaust port. See Fig. 13.

Check for missing or disconnected belt, check valve(s), diverter valve(s), air distribution manifolds, etc. Check air injection system for proper hose routing.

BLACK ARROWS - NORMAL FLOW  
CROSS HATCHED ARROWS - BY-PASS CONDITION



93G04143

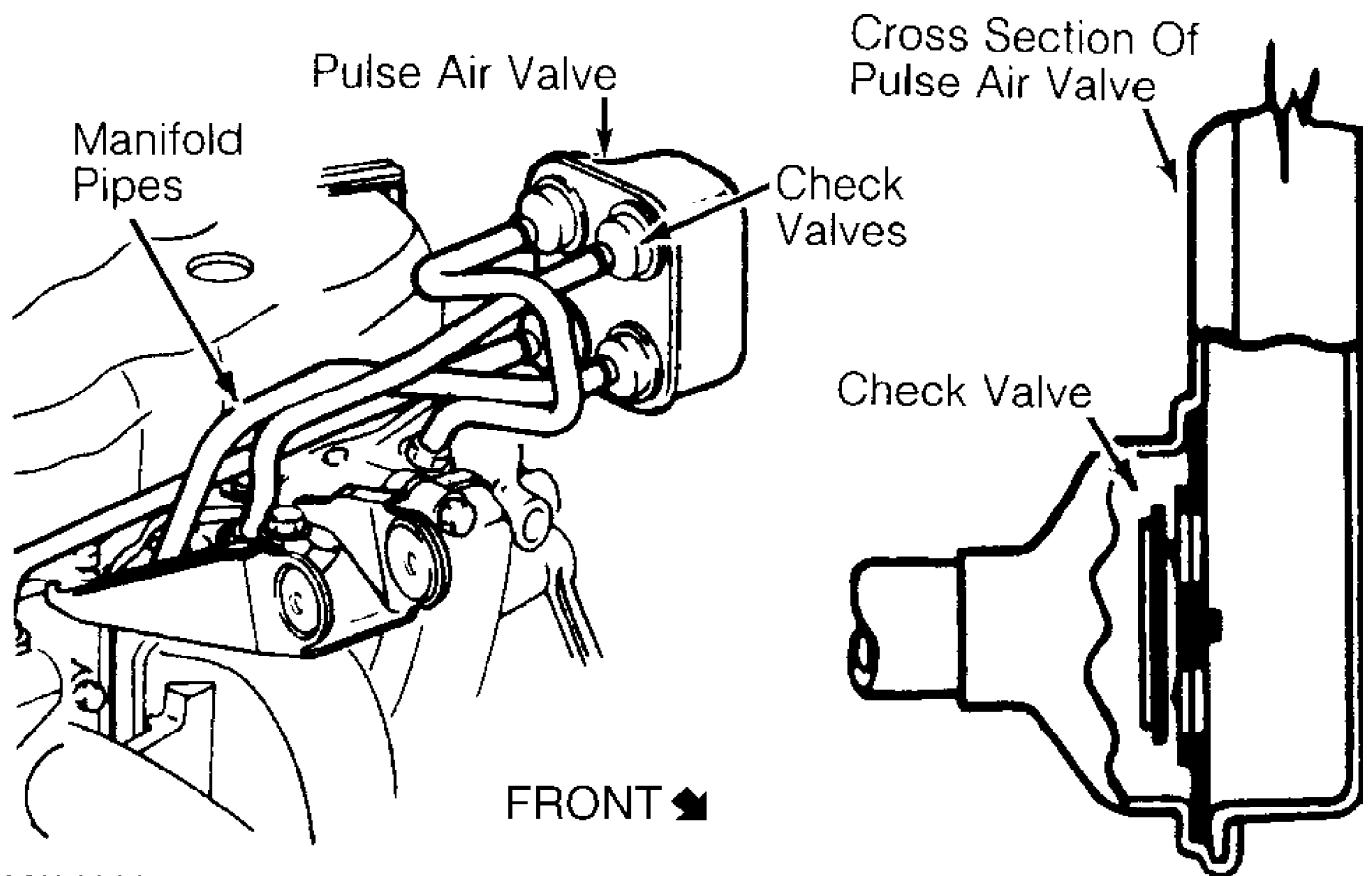
Fig. 13: Typical Air Pump Injection System  
Courtesy of General Motors Corp.

### Pulsed Secondary Air Injection (PAIR) System

PAIR eliminates the need for an air pump and most of the associated hardware. Most systems consists of air delivery pipe(s), pulse valve(s) and check valve(s). The check valve prevents exhaust gases from entering the air injection system. See Fig. 14.

Ensure required check valve(s), diverter valve(s), air distribution manifolds, etc., are present. Check air injection system for proper hose routing.





93I04144

Fig. 14: Typical Pulsed Secondary Air Injection System  
Courtesy of General Motors Corp.

### OXYGEN SENSOR (O<sub>2</sub>)

The O<sub>2</sub> sensor is mounted in the exhaust system where it monitors oxygen content of exhaust gases. Some vehicles may use 2 O<sub>2</sub> sensors. The O<sub>2</sub> sensor produces a voltage signal which is proportional to exhaust gas oxygen concentration (0-3%) compared to outside oxygen (20-21%). This voltage signal is low (about .1 volt) when a lean mixture is present and high (1.0 volt) when a rich mixture is present.

As ECM compensates for a lean or rich condition, this voltage signal constantly fluctuates between high and low, crossing a reference voltage supplied by the ECM on the O<sub>2</sub> signal line. This is referred to as cross counts. A problem in the O<sub>2</sub> sensor circuit should set a related trouble code.

### COMPUTERIZED ENGINE CONTROLS (CEC)

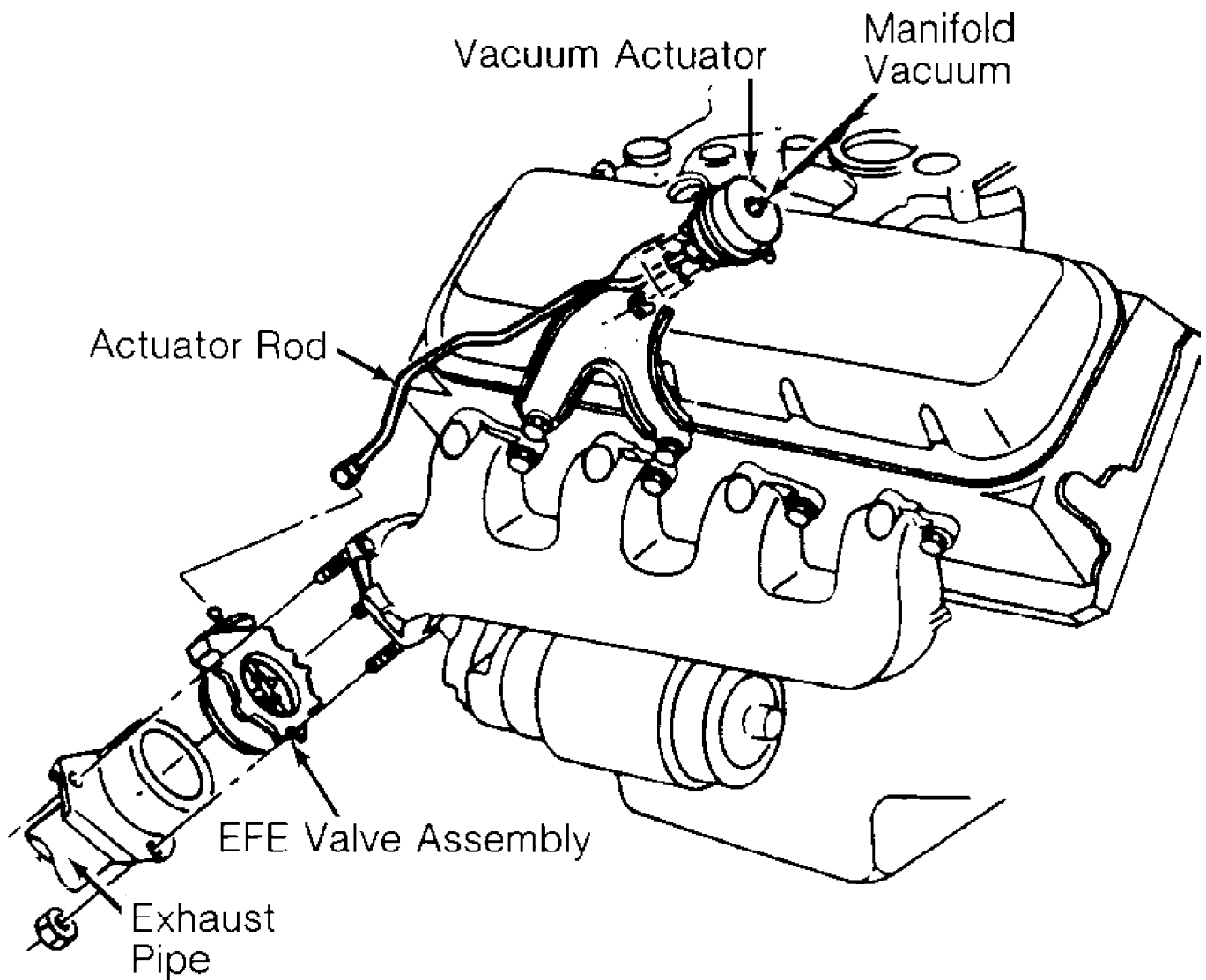
The CEC system monitors and controls a variety of engine/vehicle functions. The CEC system is primarily an emission control system designed to maintain a 14.7:1 air/fuel ratio under most operating conditions. When the ideal air/fuel ratio is maintained, the catalytic converter can control oxides of nitrogen (NO<sub>x</sub>), hydrocarbon (HC) and carbon monoxide (CO) emissions.

The CEC system consists of the following sub-systems: Electronic Control Module (ECM), input devices (sensors and switches) and output signals.

## EARLY FUEL EVAPORATION (EFE)

The EFE valve is actuated by either a vacuum actuator or a bimetal spring (heat-riser type). The EFE valve is closed when engine is cold. The closed valve restricts exhaust gas flow from the exhaust manifold. This forces part of the exhaust gas to flow up through a passage below the carburetor. As the exhaust gas quickly warms the intake mixture, distribution is improved. This results in better cold engine driveability, shorter choke periods and lower emissions.

Ensure EFE valve in exhaust manifold is not frozen or rusted in a fixed position. On vacuum-actuated EFE system, check EFE thermal vacuum valve and check valve(s). Also check for proper vacuum hose routing. See Fig. 15.



93B04145

Fig. 15: Typical Vacuum-Actuated EFE System  
Courtesy of General Motors Corp.

EMISSION MAINTENANCE REMINDER LIGHT (EMR) (IF EQUIPPED)

If equipped, the EMR light (some models may use a reminder flag) reminds vehicle operator that an emission system maintenance is required. This indicator is activated after a predetermined time/mileage.

When performing a smog check inspection, ensure EMR indicator is not activated. On models using an EMR light, light should glow when ignition switch is turned to ON position and should turn off when engine is running.

If an EMR flag is present or an EMR light stays on with engine running, fail vehicle and service or replace applicable emission-related components. To reset an EMR indicator, refer to appropriate MAINTENANCE REMINDER LIGHTS in the MAINTENANCE section.

### **MALFUNCTION INDICATOR LIGHT (MIL)**

The Malfunction Indicator Light (MIL) is used to alert vehicle operator that the computerized engine control system has detected a malfunction (when it stays on all the time with engine running). On some models, the MIL may also be used to display trouble codes.

As a bulb and system check, malfunction indicator light will glow when ignition switch is turned to ON position and engine is not running. When engine is started, light should go out.

# ENGINE COOLING FAN

## 1993 Jeep Cherokee

1993 ENGINE COOLING  
Chrysler Corp. Engine Cooling Fans

Jeep; Cherokee, Grand Cherokee, Wrangler

NOTE: Information for Grand Cherokee with 5.2L V8 engine is not available from manufacturer.

### ELECTRIC COOLING FAN

On Cherokee 4.0L engine with heavy-duty cooling and/or air conditioning, an auxiliary electric fan operates whenever engine temperature exceeds 190°F (88°C), or air conditioner is on. If Powertrain Control Module (PCM) detects a fan control circuitry problem, a fault code will set.

NOTE: For more information on vehicle self-diagnostics, see appropriate SELF-DIAGNOSTICS article in ENGINE PERFORMANCE.

### TROUBLE SHOOTING & TESTING

Electric Cooling Fan Circuit

1) Ensure fuses No. 4 and 6 on Power Distribution Center (PDC), near battery, are good. Ensure fan operates. See MOTOR under COMPONENT TESTING. Remove cooling fan relay from PDC. Start engine. Using a test light, check for power at terminal No. 2 (Light Green/Red wire) of PDC. If test light does not illuminate, repair open circuit in Light Green/Red wire between terminal No. 2 and fuse No. 4.

2) Connect a jumper wire between terminal No. 2 (Light Green/Red wire) and terminal No. 4 (Light Green wire) on PDC. If fan does not operate, leave jumper wire connected. Unplug fan connector on left side of fan shroud.

3) Using a test light, check for power at Light Green wire on fan harness connector. If no power exists, repair Light Green wire between fan harness connector and terminal No. 4 on PDC. If power exists at Light Green wire, repair open circuit in Black wire between fan harness connector and ground.

4) Turn ignition off. Reconnect fan motor connector. Remove jumper wires. Reinstall relay. Connect Diagnostic Readout Box II (DRB-II) to engine diagnostic connector. Connector is located in engine compartment, next to PCM.

5) Start engine. Energize fan relay circuit by warming engine until coolant temperature is higher than 190°F (88°C), or by turning air conditioning on (if equipped). If relay clicks but fan does not operate, check for poor relay connections at socket. If connections are okay, test relay. See RELAY under COMPONENT TESTING.

6) If relay does not click, put DRB-II into voltmeter mode. Measure voltage at cavity A1 (Dark Blue/White wire) in relay connector. If voltage is less than 10 volts, repair open circuit in Dark Blue/White wire between cavity A1 and fuse No. 6. If voltage is 10 volts or more, turn ignition off and reconnect relay.

7) Unplug connector from PCM. Examine connector. If connector is okay, turn ignition on. With DRB-II in voltmeter mode, measure voltage at terminal No. 31 (Dark Blue/Pink wire) on PCM harness connector. If voltage is 10 volts or more, replace PCM. If voltage is less than 10 volts, repair open circuit in Dark Blue/Pink wire between PCM terminal No. 31 and PDC terminal No. 5.

### COMPONENT TESTING

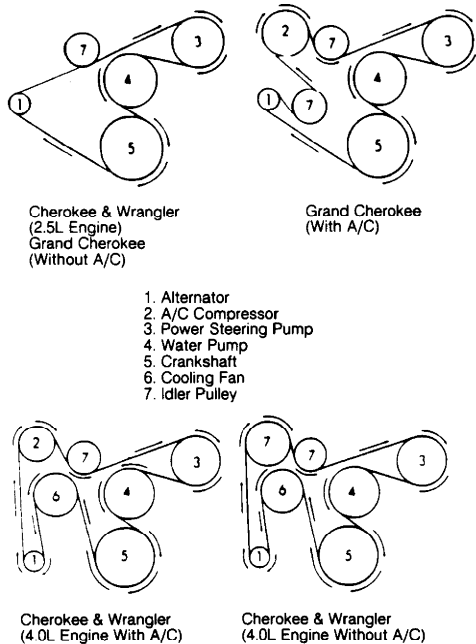
### Motor

Unplug fan motor connector at left side of fan shroud. Connect a jumper wire from terminal "B" (Black wire) of fan motor connector to a known good engine ground. Using another jumper with a 25-amp in-line fuse, supply battery power to terminal "A" (Red wire) of fan motor connector. Service fan motor if it does not run.

### Relay

1) Remove relay from Power Distribution Center (PDC). Connect a self-powered test light between relay terminals No. 2 and 4. See Fig. 1. Test light should indicate no continuity. Leave test light connected.

2) Using a jumper wire, connect relay terminal No. 5 to a good ground. Using another jumper with a 15-amp in-line fuse, supply battery power to relay terminal No. 1. If test light does not indicate continuity, replace relay.

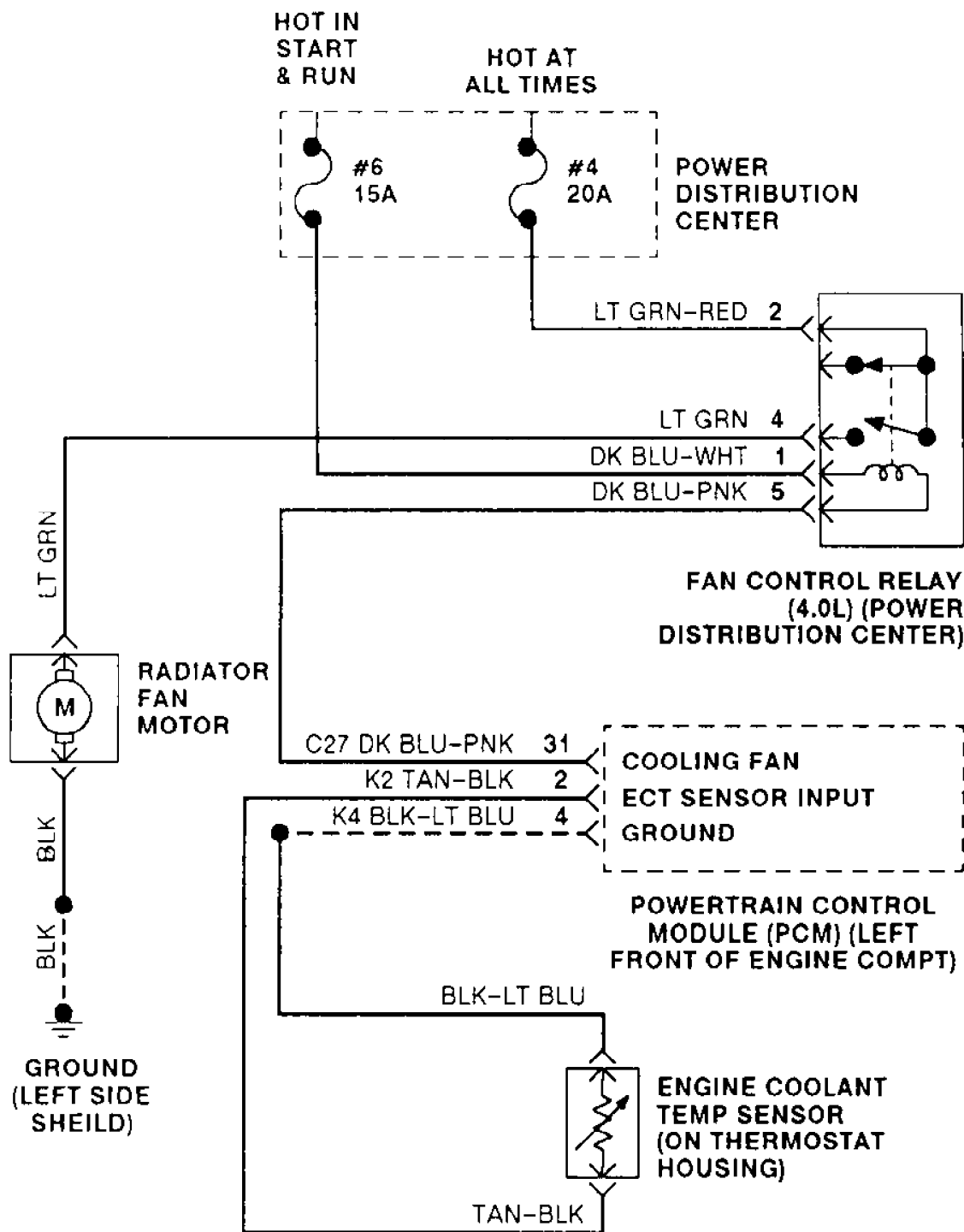


93A75911

Fig. 1: Identifying Fan Relay Connector Terminals  
Courtesy of Chrysler Corp.

## WIRING DIAGRAM

Also see appropriate chassis wiring diagram in WIRING DIAGRAMS.



**93A28944**

Fig. 2: Electric Cooling Fan Wiring Diagram

# ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION

1993 Jeep Cherokee

Engine Overhaul Procedures - General Information  
ALL PISTON ENGINES

## \* PLEASE READ THIS FIRST \*

Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## ENGINE IDENTIFICATION

The engine may be identified from its Vehicle Identification Number (VIN) stamped on a metal tab. Metal tab may be located in different locations depending on manufacturer. Engine identification number or serial number is located on cylinder block. Location varies with manufacturer.

## INSPECTION PROCEDURES

### \* PLEASE READ THIS FIRST \*

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## GENERAL

Engine components must be inspected to meet manufacturer's specifications and tolerances during overhaul. Proper dimensions and tolerances must be met to obtain proper performance and maximum engine life.

Micrometers, depth gauges and dial indicator are used for checking tolerances during engine overhaul. Magnaflux, Magnaglo, dye-check, ultrasonic and x-ray inspection procedures are used for parts inspection.

## MAGNETIC PARTICLE INSPECTION

Magnaflux & Magnaglo

Magnaflux is an inspection technique used to locate material flaws and stress cracks. The part in question is subjected to a strong magnetic field. The entire part, or a localized area, can be magnetized. The part is coated with either a wet or dry material that contains fine magnetic particles.

Cracks which are outlined by the particles cause an interruption in the magnetic field. The dry powder method of Magnaflux can be used in normal light. A crack will appear as an obvious bright line.

Fluorescent liquid is used in conjunction with a blacklight in a second Magnaflux system called Magnaglo. This type of inspection demands a darkened room. The crack will appear as a glowing line in this process. Both systems require complete demagnetizing upon

completion of the inspection. Magnetic particle inspection applies to ferrous materials only.

## **PENETRANT INSPECTION**

### **Zyglo**

The Zyglo process coats the material with a fluorescent dye penetrant. The part is often warmed to expand cracks that will be penetrated by the dye. When the coated part is subjected to inspection with a blacklight, a crack will glow brightly. Developing solution is often used to enhance results. Parts made of any material, such as aluminum cylinder heads or plastics, may be tested using this process.

### **Dye Check**

Penetrating dye is sprayed on the previously cleaned component. Dye is left on component for 5-45 minutes, depending upon material density. Component is then wiped clean and sprayed with a developing solution. Surface cracks will show up as a bright line.

## **ULTRASONIC INSPECTION**

If an expensive part is suspected of internal cracking, Ultrasonic testing is used. Sound waves are used for component inspection.

## **X-RAY INSPECTION**

This form of inspection is used on highly stressed components. X-ray inspection maybe used to detect internal and external flaws in any material.

## **PRESSURE TESTING**

Cylinder heads can be tested for cracks using a pressure tester. Pressure testing is performed by plugging all but one of the holes in the head and injecting air or water into the open passage. Leaks are indicated by the appearance of wet or damp areas when using water. When air is used, it is necessary to spray the head surface with a soap solution. Bubbles will indicate a leak. Cylinder head may also be submerged in water heated to specified temperature to check for cracks created during heat expansion.

## **CLEANING PROCEDURES**

### **\* PLEASE READ THIS FIRST \***

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## **GENERAL**

All components of an engine do not have the same cleaning requirements. Physical methods include bead blasting and manual removal. Chemical methods include solvent blast, solvent tank, hot tank, cold tank and steam cleaning of components.

## **BEAD BLASTING**

Manual removal of deposits may be required prior to bead blasting, followed by some other cleaning method. Carbon, paint and



rust may be removed using bead blasting method. Components must be free of oil and grease prior to bead blasting. Beads will stick to grease or oil soaked areas causing area not to be cleaned.

Use air pressure to remove all trapped residual beads from components after cleaning. After cleaning internal engine parts made of aluminum, wash thoroughly with hot soapy water. Component must be thoroughly cleaned as glass beads will enter engine oil resulting in bearing damage.

## **CHEMICAL CLEANING**

Solvent tank is used for cleaning oily residue from components. Solvent blasting sprays solvent through a siphon gun using compressed air.

The hot tank, using heated caustic solvents, is used for cleaning ferrous materials only. DO NOT clean aluminum parts such as cylinder heads, bearings or other soft metals using the hot tank. After cleaning, flush parts with hot water.

A non-ferrous part will be ruined and caustic solution will be diluted if placed in the hot tank. Always use eye protection and gloves when using the hot tank.

Use of a cold tank is for cleaning of aluminum cylinder heads, carburetors and other soft metals. A less caustic and unheated solution is used. Parts may be left in the tank for several hours without damage. After cleaning, flush parts with hot water.

Steam cleaning, with boiling hot water sprayed at high pressure, is recommended as the final cleaning process when using either hot or cold tank cleaning.

## **COMPONENT CLEANING**

**\* PLEASE READ THIS FIRST \***

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## **SHEET METAL PARTS**

Examples of sheet metal parts are the rocker covers, front and side covers, oil pan and bellhousing dust cover. Glass bead blasting or hot tank may be used for cleaning.

Ensure all mating surfaces are flat. Deformed surfaces should be straightened. Check all sheet metal parts for cracks and dents.

## **INTAKE & EXHAUST MANIFOLDS**

Using solvent cleaning or bead blasting, clean manifolds for inspection. If the intake manifold has an exhaust crossover, all carbon deposits must be removed. Inspect manifolds for cracks, burned or eroded areas, corrosion and damage to fasteners.

Exhaust heat and products of combustion cause threads of fasteners to corrode. Replace studs and bolts as necessary. On "V" type intake manifolds, the sheet metal oil shield must be removed for proper cleaning and inspection. Ensure that all manifold parting surfaces are flat and free of burrs.

## **CYLINDER HEAD REPLACEMENT**

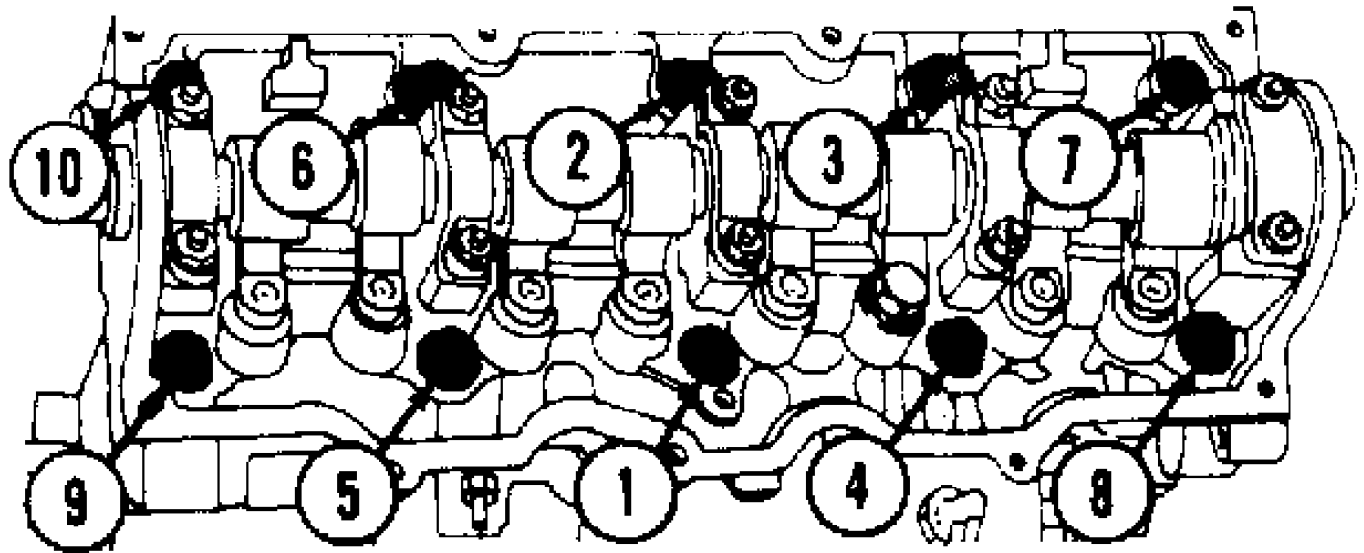
**\* PLEASE READ THIS FIRST \***

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## REMOVAL

Remove intake and exhaust manifolds and valve cover. Cylinder head and camshaft carrier bolts (if equipped), should be removed only when the engine is cold. On many aluminum cylinder heads, removal while hot will cause cylinder head warpage. Mark rocker arm or overhead cam components for location.

Remove rocker arm components or overhead cam components. Components must be installed in original location. Individual design rocker arms may utilize shafts, ball-type pedestal mounts or no rocker arms. For all design types, wire components together and identify according to the corresponding valve. Remove cylinder head bolts. Note length and location. Some applications require cylinder head bolts be removed in proper sequence to prevent cylinder head damage. See Fig. 1. Remove cylinder head.



● FRONT OF VEHICLE

Fig. 1: Typical Cylinder Head Tightening or Loosening Sequence  
This Graphic For General Information Only

## INSTALLATION

Ensure all surfaces and head bolts are clean. Check that head bolt holes of cylinder block are clean and dry to prevent block damage when bolts are tightened. Clean threads with tap to ensure accurate bolt torque.

Install head gasket on cylinder block. Some manufacturer's may recommend sealant be applied to head gasket prior to installation. Note that all holes are aligned. Some gasket applications may be marked so certain area faces upward. Install cylinder head using care not to damage head gasket. Ensure cylinder head is fully seated on cylinder block.

Some applications require head bolts be coated with sealant prior to installation. This is done if head bolts are exposed to water passages. Some applications require head bolts be coated with light coat of engine oil.

Install head bolts. Head bolts should be tightened in proper steps and sequence to specification. See Fig. 1. Install remaining components. Tighten all bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

NOTE: Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

## VALVE ADJUSTMENT

Engine specifications will indicate valve train clearance and temperature at which adjustment is to be made on most models. In most cases, adjustment will be made with a cold engine. In some cases, both a cold and a hot clearance will be given for maintenance convenience.

On some models, adjustment is not required. Rocker arms are tightened to specification and valve lash is automatically set. On some models with push rod actuated valve train, adjustment is made at push rod end of rocker arm while other models do not require adjustment.

Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

Some models require hydraulic lifter to be bled down and clearance measured. Different length push rods can be used to obtain proper clearance. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge.

On overhead cam engines designed without rocker arms actuate valves directly on a cam follower. A hardened, removable disc is installed between the cam lobe and lifter. Clearance will be checked between cam heel and adjusting disc in proper sequence using a feeler gauge. Engine will be rotated to obtain all valve adjustments.

On overhead cam engines designed with rocker arms, adjustment is made at push rod end of rocker arm. Ensure that the valve to be adjusted is riding on the heel of the cam on all engines. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

## CYLINDER HEAD OVERHAUL

### \* PLEASE READ THIS FIRST \*

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## DISASSEMBLY

Mark valves for location. Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator, valve spring, spring seat and valve. See Fig. 2.

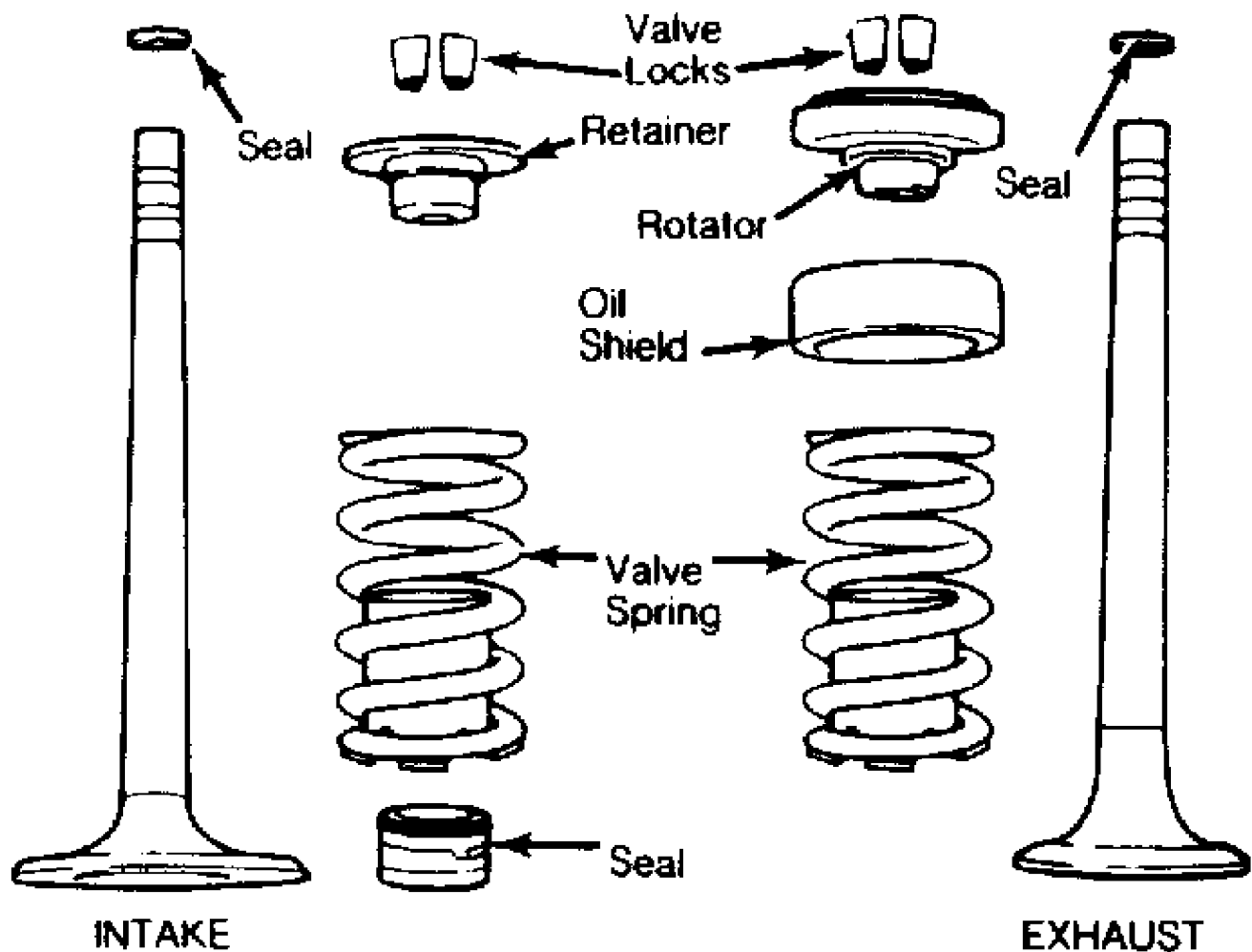


Fig. 2: Exploded View of Intake & Exhaust Valve Assemblies - Typical  
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## CLEANING & INSPECTION

Clean cylinder head and valve components using approved cleaning methods. Inspect cylinder head for cracks, damage or warped gasket surface. Place straightedge across gasket surface. Determine clearance at center of straightedge. Measure across both diagonals, longitudinal centerline and across the head at several points. See Fig. 3.

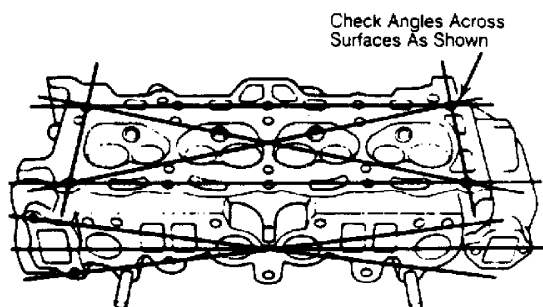


Fig. 3: Checking Cylinder Head for Warpage - Typical  
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On cast cylinder heads, if warpage exceeds .003" (.08 mm) in a 6" span, or .006" (.15 mm) over total length, cylinder head must be resurfaced. On most aluminum cylinder heads, if warpage exceeds .002" (.05 mm) in any area, cylinder head must be resurfaced. Warpage specification may vary with manufacturer.

Cylinder head thickness should be measured to determine amount of material which can be removed before replacement is required. Cylinder head thickness must not be less than manufacturer's specifications.

If cylinder head required resurfacing, it may not align properly with intake manifold. On "V" type engines, misalignment is corrected by machining intake manifold surface that contacts cylinder head. Cylinder head may be machined on surface that contacts intake manifold.

Using oil stone, remove burrs or scratches from all sealing surfaces.

## VALVE SPRINGS

Inspect valve springs for corroded or pitted valve spring surfaces which may lead to breakage. Polished spring ends caused by a rotating spring, indicates that spring surge has occurred. Replace springs showing evidence of these conditions.

Inspect valve springs for squareness using a 90 degree straightedge. See Fig. 4. Replace valve spring if out-of-square exceeds manufacturer's specification.

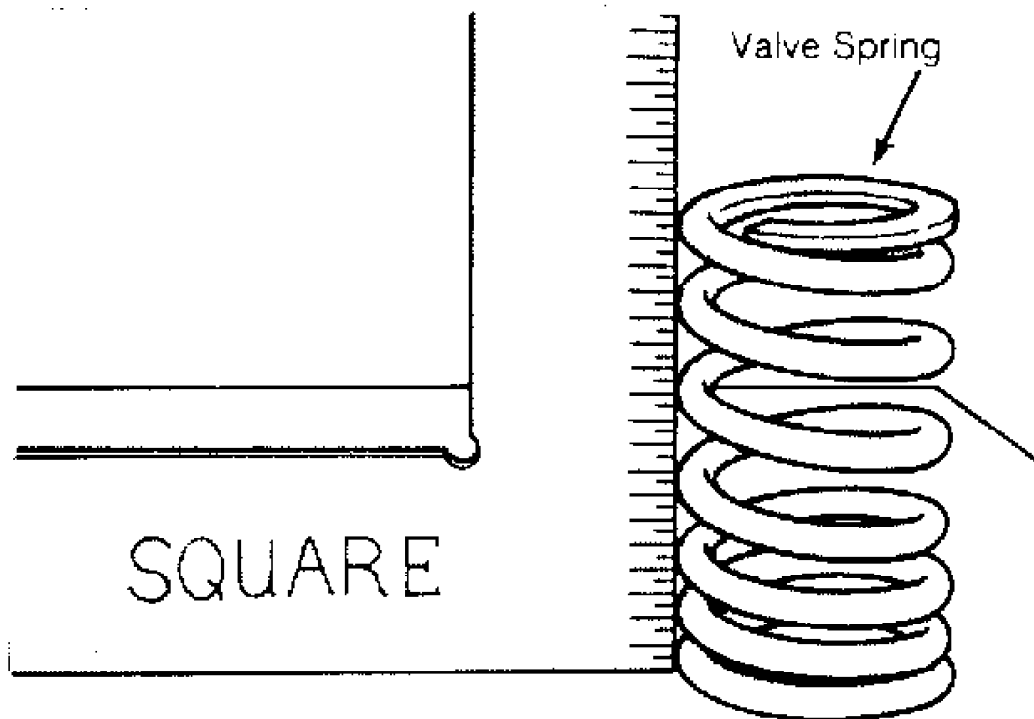
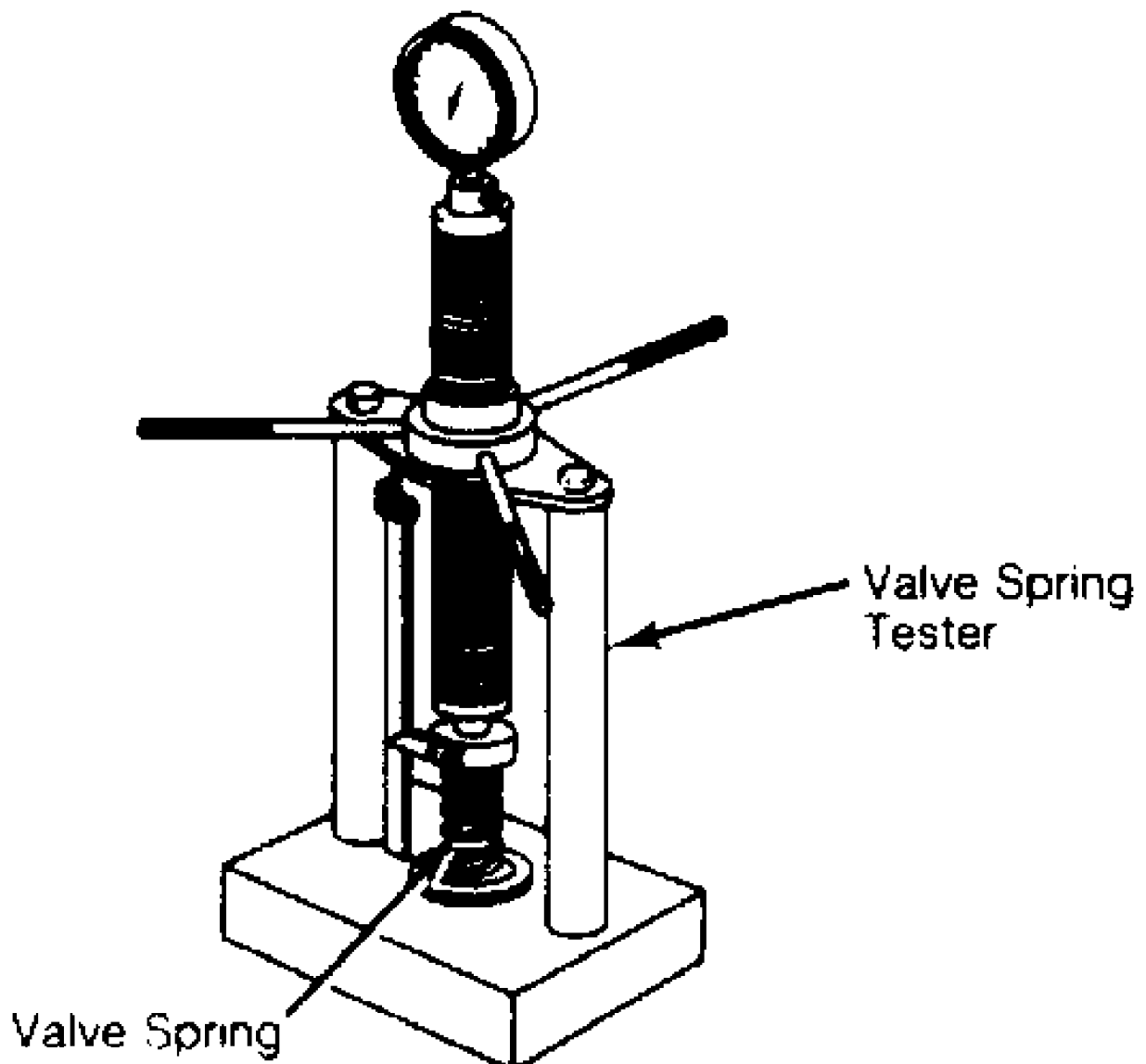


Fig. 4: Checking Valve Spring Squareness - Typical  
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Using vernier caliper, measure free length of all valve springs. Replace springs if not within specification. Using valve

spring tester, test valve spring pressure at installed and compressed heights. See Fig. 5.

Usually compressed height is installed height minus valve lift. Replace valve spring if not within specification. It is recommended to replace all valve springs when overhauling cylinder head.



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Fig. 5: Checking Valve Spring Pressure - Typical  
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## VALVE GUIDE

### Measuring Valve Guide Clearance

Check valve stem-to-guide clearance. Ensure valve stem diameter is within specifications. Install valve in valve guide. Install dial indicator assembly on cylinder head with tip resting against valve stem just above valve guide. See Fig. 6.

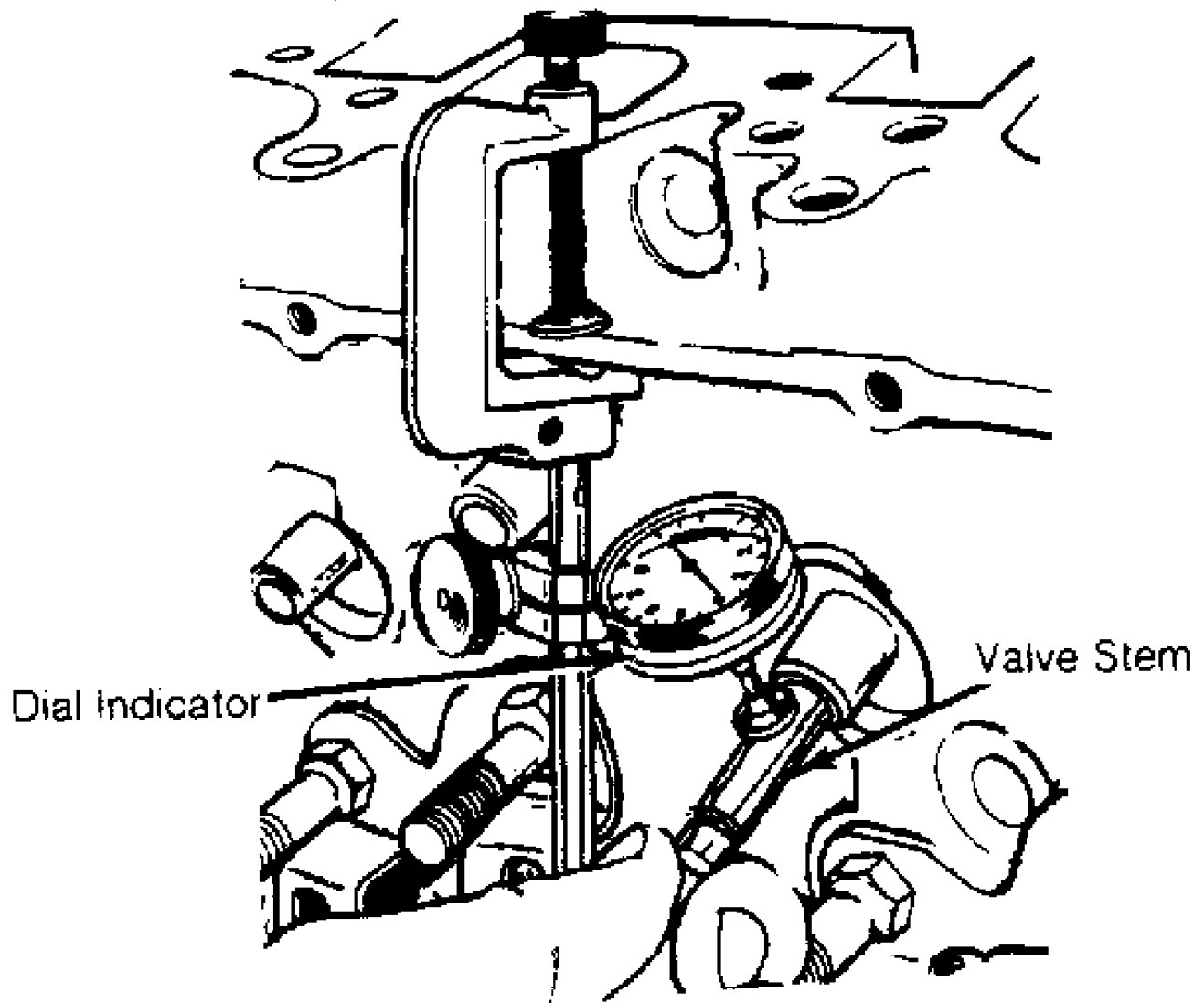


Fig. 6: Measuring Valve Stem-to-Guide Clearance - Typical  
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Lower valve approximately  $1/16$ " below valve seat. Push valve stem against valve guide as far as possible. Adjust dial indicator to zero. Push valve stem in opposite direction and note reading. Clearance must be within specification.

If valve guide clearance exceeds specification, valves with oversize stems may be used or valve guide must be replaced. On some applications, a false guide is installed, then reamed to proper specification. Valve guide reamer set is used to ream valve guide to obtain proper clearance for new valve.

#### Reaming Valve Guide

Select proper reamer for valve stem. Reamer must be of proper length to provide clean cut through entire length of valve guide. Install reamer in valve guide and rotate to cut valve guide. See Fig. 7.

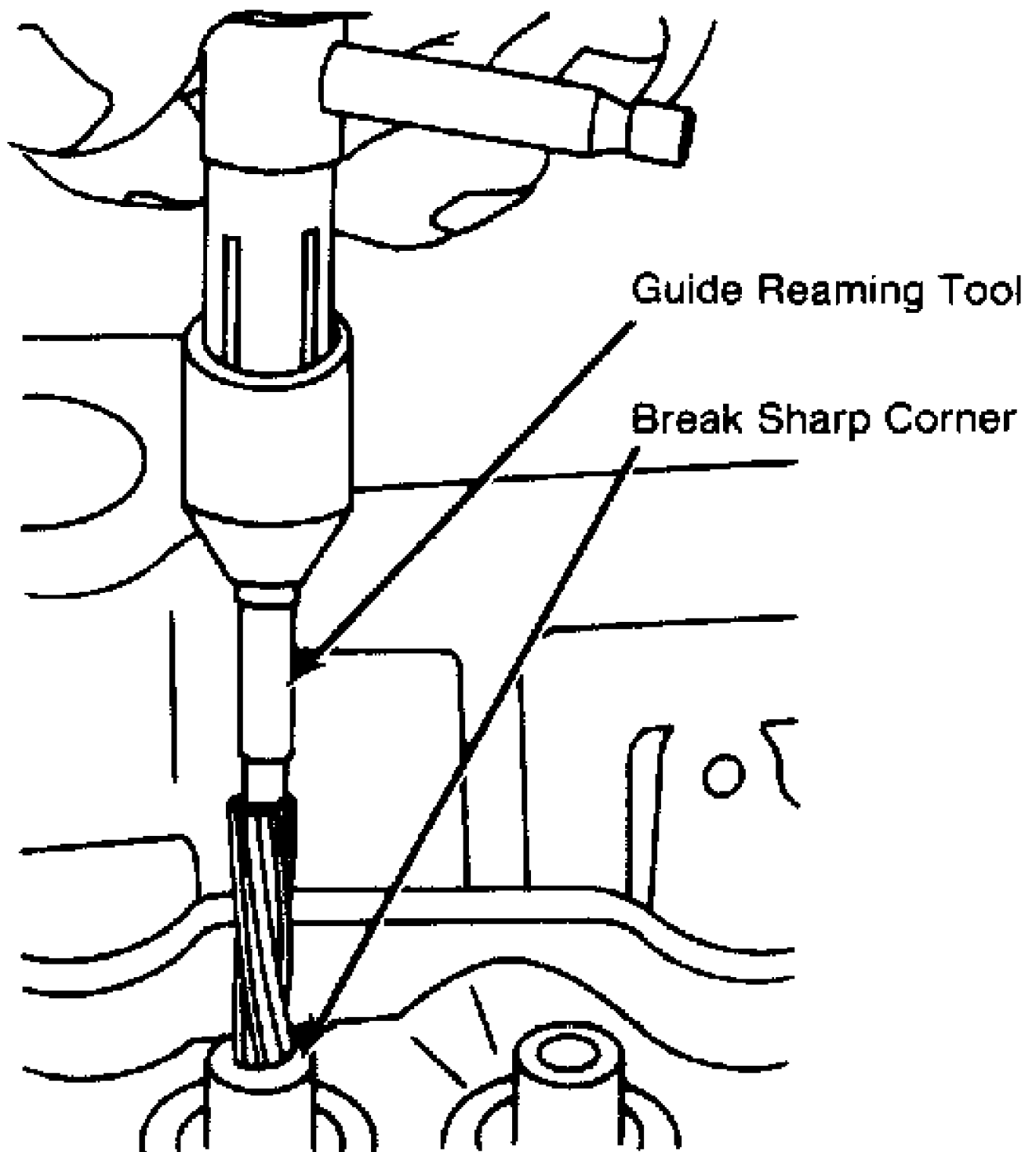


Fig. 7: Reaming Valve Guides - Typical  
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#### Replacing Valve Guide

Replace valve guide if clearance exceeds specification. Valve guides are either pressed, hammered or shrunk in place, depending upon



cylinder head design and type of metal used.

Remove valve guide from cylinder head by pressing or tapping on a stepped drift. See Fig. 8. Once valve guide is installed, distance from cylinder head to top of valve guide must be checked. This distance must be within specification.

Aluminum heads are often heated before installing valve guide. Guide is sometimes chilled in dry ice before installation. Combination of a heated head and chilled guide insures a tight guide fit upon assembly. The new guide must be reamed to specification.

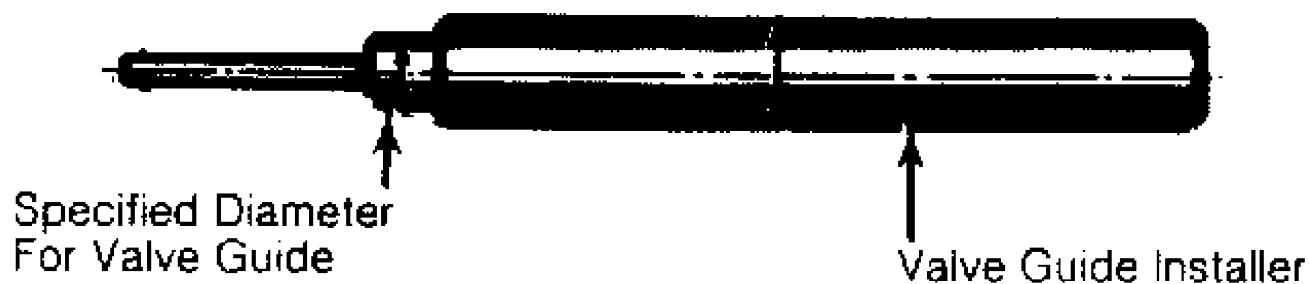


Fig. 8: Typical Valve Guide Remover & Installer  
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## VALVES & VALVE SEATS

### Valve Grinding

Valve stem O.D. should be measured in several areas to indicate amount of wear. Replace valve if not within specification. Valve margin area should be measured to ensure that valve can be grounded. See Fig. 9.

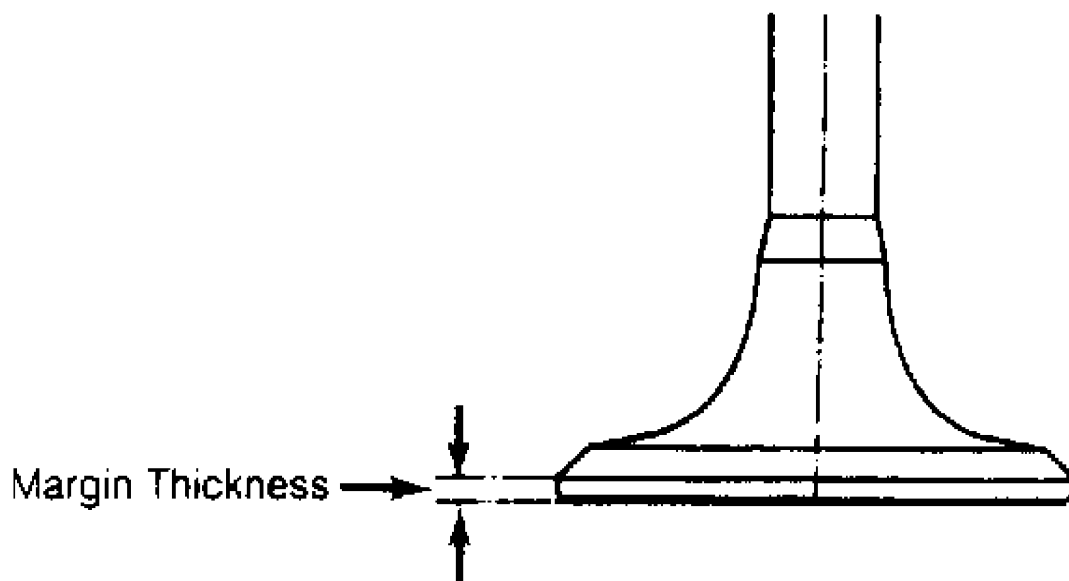


Fig. 9: Measuring Valve Head Margin - Typical  
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If valve margin is less than specification, this will burn the valves. Valve must be replaced. Due to minimum margin dimensions

during manufacture, some new type valves cannot be reground.

Resurface valve on proper angle specification using valve grinding machine. Follow manufacturer's instructions for valve grinding machine. Specifications may indicate a different valve face angle than seat angle.

Measure valve margin after grinding. Replace valve if not within specification. Valve stem tip can be refinished using valve grinding machine.

#### Valve Lapping

During valve lapping of recent designed valves, be sure to follow manufacturers recommendations. Surface hardening and materials used with some valves do not permit lapping. Lapping process will remove excessive amounts of the hardened surface.

Valve lapping is done to ensure adequate sealing between valve face and seat. Use either a hand drill or lapping stick with suction cup attached.

Moisten and attach suction cup to valve. Lubricate valve stem and guide. Apply a thin coat of fine valve grinding compound between valve and seat. Rotate lapping tool between the palms or with hand drill.

Lift valve upward off the seat and change position often. This is done to prevent grooving of valve seat. Lap valve until a smooth polished seat is obtained. Thoroughly clean grinding compound from components. Valve to valve seat concentricity should be checked. See VALVE SEAT CONCENTRICITY.

**CAUTION:** Valve guides must be in good condition and free of carbon deposits prior to valve seat grinding. Some engines contain an induction hardened valve seat. Excessive material removal will damage valve seats.

#### Valve Seat Grinding

Select coarse stone of correct size and angle for seat to be ground. Ensure stone is true and has a smooth surface. Select correct size pilot for valve guide dimension. Install pilot in valve guide. Lightly lubricate pilot shaft. Install stone on pilot. Move stone off and on the seat approximately 2 times per second during grinding operation.

Select a fine stone to finish grinding operation. Grinding stones with 30 and 60 degree angles are used to center and narrow the valve seat as required. See Fig. 10.

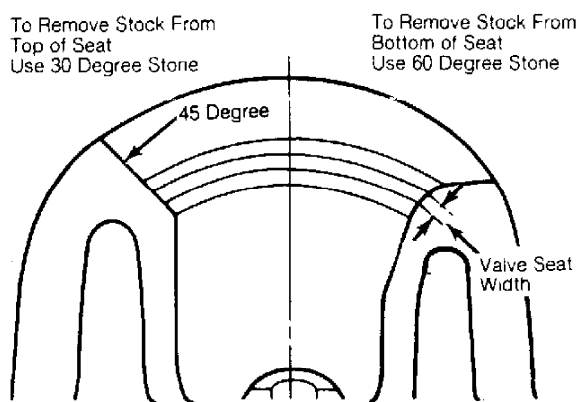


Fig. 10: Adjusting Valve Seat Width - Typical  
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#### Valve Seat Replacement

Replacement of valve seat inserts is done by cutting out

the old insert and machining an oversize insert bore. Replacement oversize insert is usually chilled and the cylinder head is sometimes warmed. Valve seat is pressed into the head. This operation requires specialized machine shop equipment.

#### Valve Seat Concentricity

Using dial gauge, install gauge pilot in valve guide. Position gauge arm on the valve seat. Adjust dial indicator to zero. Rotate arm 360 degrees and note reading. Runout should not exceed specification.

To check valve-to-valve seat concentricity, coat valve face lightly with Prussian Blue dye. Install valve and rotate it on valve seat. If pattern is even and entire seat is coated at valve contact point, valve is concentric with the seat.

### REASSEMBLY

#### Valve Stem Installed Height

Valve stem installed height must be checked when new valves are installed or when valves or valve seats have been ground. Install valve in valve guide. Measure distance from tip of valve stem to spring seat. See Fig. 11. Distance must be within specifications.

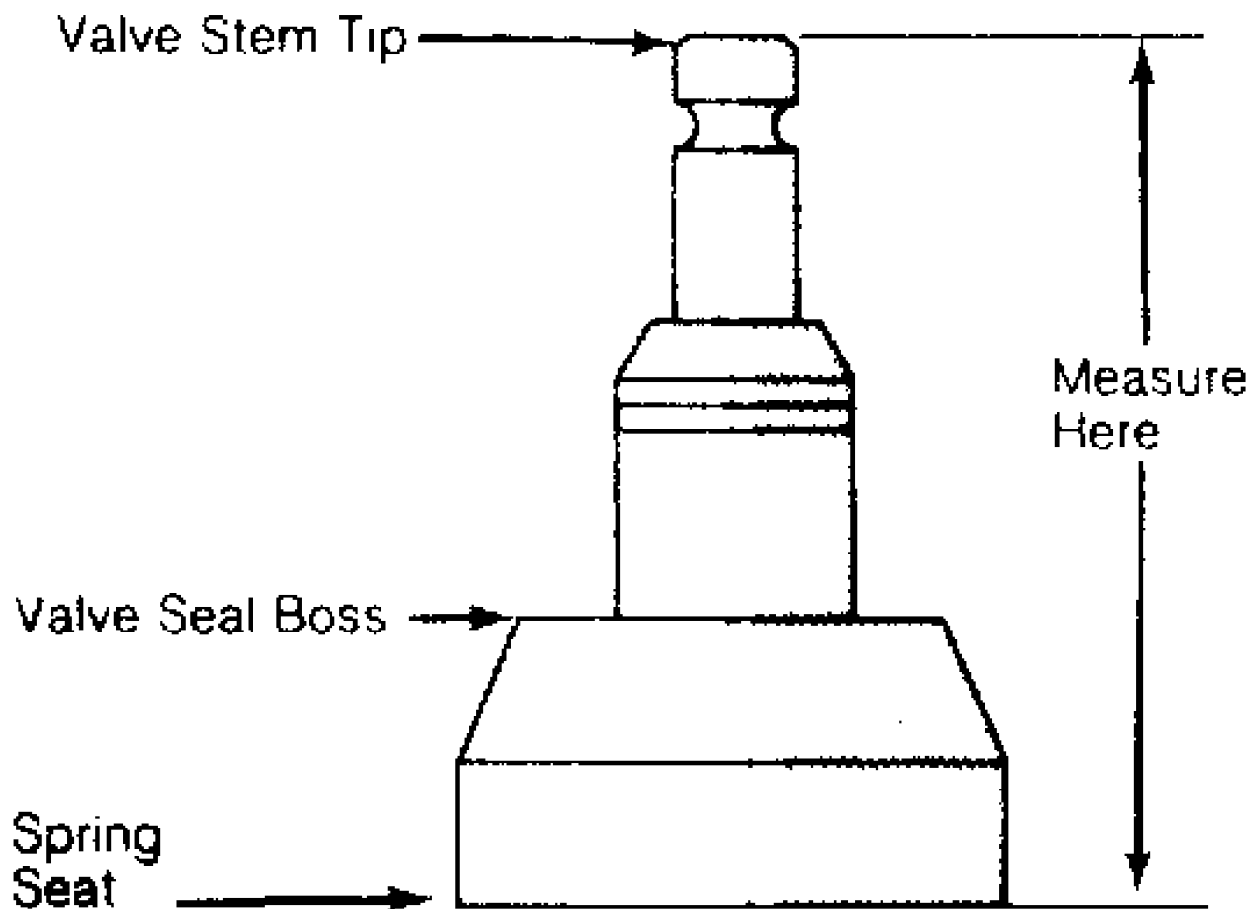


Fig. 11: Measuring Valve Stem Installed Height - Typical  
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Remove valve and grind valve stem tip if height exceeds specification. Valve tips are surface hardened. DO NOT remove more

than .010" (.25 mm) from tip. Chamfer sharp edge of reground valve tip. Recheck valve stem installed height.

## VALVE STEM OIL SEALS

Valve stem oil seals must be installed on valve stem. See Fig. 2. Seals are needed due to pressure differential at the ends of valve guides. Atmospheric pressure above intake guide, combined with manifold vacuum below guide, causes oil to be drawn into the cylinder.

Exhaust guides also have pressure differential created by exhaust gas flowing past the guide, creating a low pressure area. This low pressure area draws oil into the exhaust system.

### Replacement (On Vehicle)

Mark rocker arm or overhead cam components for location. Remove rocker arm components or overhead cam components. Components must be installed in original location. Remove spark plugs. Valve stem oil seals may be replaced by holding valves against seats using air pressure.

Air pressure must be installed in cylinder using an adapter for spark plug hole. An adapter can be constructed by welding air hose connection to spark plug body with porcelain removed.

Install adapter in spark plug hole. Apply a minimum of 140 psi (9.8 kg/cm<sup>2</sup>) to adapter. Air pressure should hold valve closed. If air pressure does not hold valve closed, check for damaged or bent valve. Cylinder head must be removed for service.

Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator and valve spring. Remove valve stem oil seal.

If oversized valves have been installed, oversized oil seals must be used. Coat valve stem with engine oil. Install protective sleeve over end of valve stem. Install new oil seal over valve stem and seat on valve guide. Remove protective sleeve. Install spring seat, valve spring and retainer or rotator. Compress spring and install valve locks. Remove spring compressor. Ensure valve locks are fully seated.

Install rocker arms or overhead cam components. Tighten all bolts to specification. Adjust valves if required. Remove adapter. Install spark plugs, valve cover and gasket.

## VALVE SPRING INSTALLED HEIGHT

Valve spring installed height should be checked during reassembly. Measure height from lower edge of valve spring to the upper edge. DO NOT include valve spring seat or retainer. Distance must be within specifications. If valves and/or seats have been ground, a valve spring shim may be required to correct spring height. See Fig. 12.

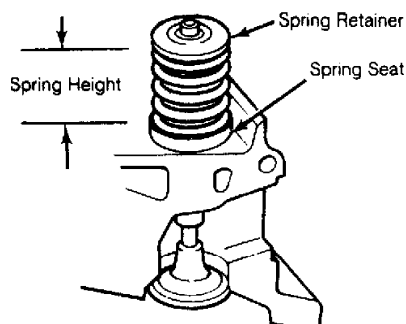


Fig. 12: Measuring Valve Spring Installed Height - Typical  
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## ROCKER ARMS & ASSEMBLIES

### Rocker Studs

Rocker studs are either threaded or pressed in place.

Threaded studs are removed by locking 2 nuts on the stud. Unscrew the stud by turning the jam nut. Coat the stud threads with Loctite and install. Tighten to specification.

Pressed in stud can be removed using a stud puller. Ream the stud bore to proper specification and press in a new oversize stud. Pressed in studs are often replaced by cutting threads in the stud bore to accept a threaded stud.

### Rocker Arms & Shafts

Mark rocker arms for location. Remove rocker arm retaining bolts. Remove rocker arms. Inspect rocker arms, shafts, bushings and pivot balls (if equipped) for excessive wear. Inspect rocker arms for wear in valve stem contact area. Measure rocker arm bushing I.D. Replace bushings if excessively worn.

The rocker arm valve stem contact point can be reground, using special fixture for valve grinding machine. Remove minimum amount of material as possible. Ensure all oil passages are clear. Install rocker arms in original locations. Ensure rocker arm is properly seated in push rod. Tighten bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

### Pushrods

Remove rocker arms. Mark push rods for location. Remove push rods. Push rods can be steel or aluminum, solid or hollow. Hollow pushrods must be internally cleaned to ensure oil passage to the rocker arms is cleaned. Check the pushrod for damage, such as loose ends on steel tipped aluminum types.

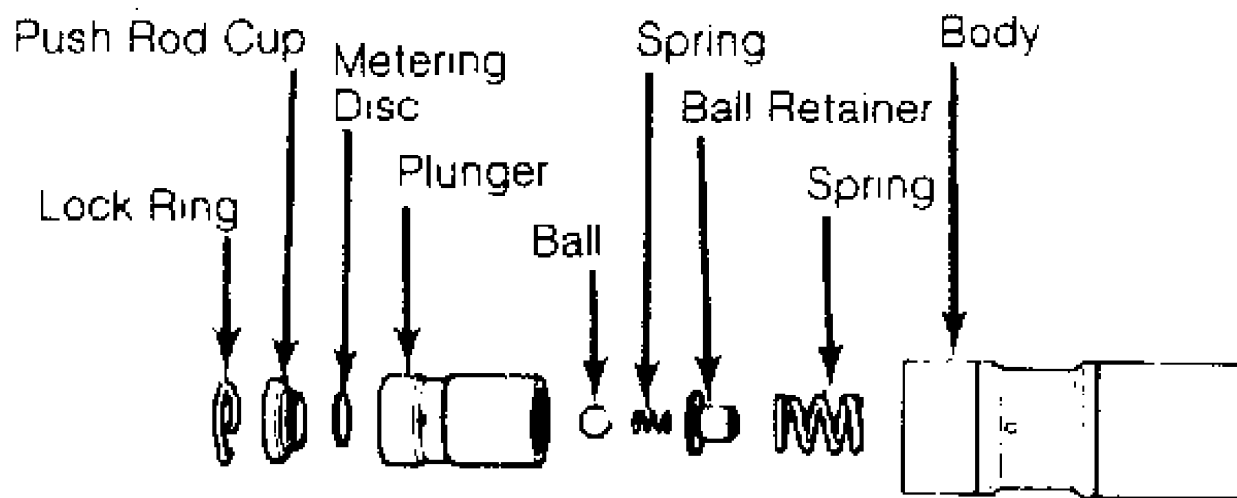
Check push rod for straightness. Roll push rod on a flat surface. Using feeler gauge, check clearance at center. Replace push rod if bent. The push rod can also be supported at each end and rotated. A dial indicator is used to detect bends in the push rod.

Lubricate ends of push rod and install push rod in original location. Ensure push rod is properly seated in lifter. Install rocker arm. Tighten bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

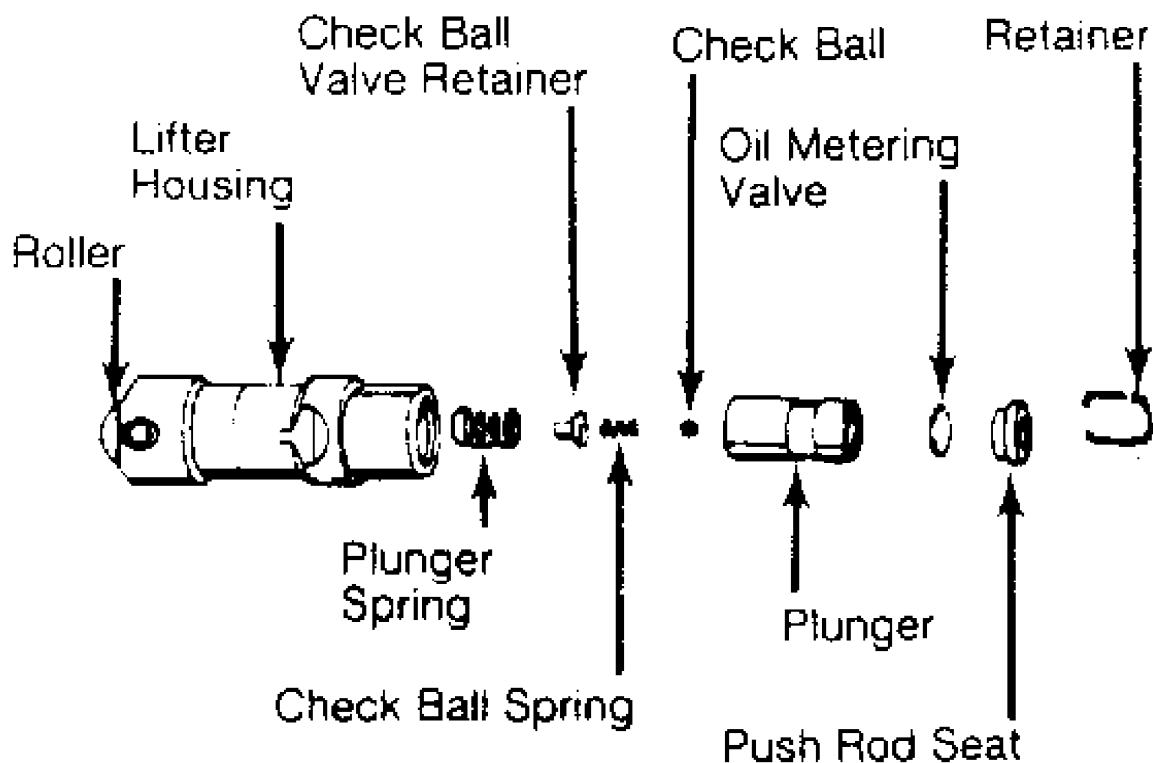
## LIFTERS

### Hydraulic Lifters

Before replacing a hydraulic lifter for noisy operation, ensure noise is not caused by worn rocker arms or valve tips. Hydraulic lifter assemblies must be installed in original locations. Remove the rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold, or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use a hydraulic lifter remover or magnet. Different type lifters are used. See Fig. 13.



FLAT LIFTER



ROLLER LIFTER

Fig. 13: Typical Hydraulic Valve Lifter Assemblies - Typical  
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On sticking lifters, disassemble and clean lifter. DO NOT mix lifter components or positions. Parts are select-fitted and are not

interchangeable. Inspect all components for wear. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. On roller type lifters, inspect roller for flaking, pitting, loss of needle bearings and roughness during rotation.

Measure lifter body O.D. in several areas. Measure lifter bore I.D. of cylinder block. Some models offer oversized lifters. Replace lifter if damaged.

If lifter check valve is not operating, obstructions may be preventing it from closing or valve spring may be broken. Clean or replace components as necessary.

Check plunger operation. Plunger should drop to bottom of the body by its own weight when assembled dry. If plunger is not free, soak lifter in solvent to dissolve deposits.

Lifter leak-down test can be performed on lifter. Lifter must be filled with special test oil. New lifters contain special test oil. Using lifter leak-down tester, perform leak-down test following manufacturer's instructions. If leak-down time is not within specifications, replace lifter assembly.

Lifters should be soaked in clean engine oil several hours prior to installation. Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. See Fig. 13. Install lifter in original location. Install remaining components. Valve lash adjustment is not required on most hydraulic lifters. Preload of hydraulic lifter is automatic. Some models may require adjustment.

#### Mechanical Lifters

Lifter assemblies must be installed in original locations. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use lifter remover or magnet.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. Install lifter in original location. Install remaining components. Tighten bolts to specification. Adjust valves. See VALVE ADJUSTMENT in this article.

## PISTONS, CONNECTING RODS & BEARINGS

### \* PLEASE READ THIS FIRST \*

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

### RIDGE REMOVAL

Ridge in cylinder wall must be removed prior to piston removal. Failure to remove ridge prior to removing pistons will cause piston damage in piston ring locations.

With the piston at bottom dead center, place a rag in the bore to trap metal chips. Install ridge reamer in cylinder bore. Adjust ridge reamer using manufacturer's instructions. Remove ridge

using ridge reamer. DO NOT remove an excessive amount of material. Ensure ridge is completely removed.

## PISTON & CONNECTING ROD REMOVAL

Note top of piston. Some pistons may contain a notch, arrow or be marked "FRONT". Piston must be installed in proper direction to prevent damage with valve operation.

Check that connecting rod and cap are numbered for cylinder location and which side of cylinder block the number faces. Proper cap and connecting rod must be installed together. Connecting rod cap must be installed on connecting rod in proper direction to ensure bearing lock procedure. Mark connecting rod and cap if necessary. Pistons must be installed in original location.

Remove cap retaining nuts or bolts. Remove bearing cap. Install stud protectors on connecting rod bolts. This protects cylinder walls from scoring during removal. Ensure proper removal of ridge. Push piston and connecting rod from cylinder. Connecting rod boss can be tapped with a wooden dowel or hammer handle to aid in removal.

## PISTON & CONNECTING ROD

### Disassembly

Using ring expander, remove piston rings. Remove piston pin retaining rings (if equipped). On pressed type piston pins, special fixtures and procedures according to manufacturer must be used to remove piston pins. Follow manufacturer's recommendations to avoid piston distortion or breakage.

### Cleaning

Remove all carbon and varnish from piston. Pistons and connecting rods may be cleaned in cold type chemical tank. Using ring groove cleaner, clean all deposits from ring grooves. Ensure all deposits are cleaned from ring grooves to prevent ring breakage or sticking. DO NOT attempt to clean pistons using wire brush.

### Inspection

Inspect pistons for nicks, scoring, cracks or damage in ring areas. Connecting rod should be checked for cracks using Magnaflux procedure. Piston diameter must be measured in manufacturers specified area.

Using telescopic gauge and micrometer, measure piston pin bore of piston in 2 areas, 90 degrees apart. This is done to check diameter and out-of-round.

Install proper bearing cap on connecting rod. Ensure bearing cap is installed in proper location. Tighten bolts or nuts to specification. Using inside micrometer, measure inside diameter in 2 areas, 90 degrees apart.

Connecting rod I.D. and out-of-round must be within specification. Measure piston pin bore I.D. and piston pin O.D. All components must be within specification. Subtract piston pin diameter from piston pin bore in piston and connecting rod to determine proper fit.

Connecting rod length must be measured from center of crankshaft journal inside diameter to center of piston pin bushing using proper caliper. Connecting rods must be the same length. Connecting rods should be checked on an alignment fixture for bent or twisted condition. Replace all components which are damaged or not within specification.

## PISTON & CYLINDER BORE FIT



Ensure cylinder is checked for taper, out-of-round and properly honed prior to checking piston and cylinder bore fit. See CYLINDER BLOCK in this article. Using dial bore gauge, measure cylinder bore. Measure piston at right angle to piston pin in center of piston skirt area. Subtract piston diameter from cylinder bore diameter. The difference is piston-to-cylinder clearance. Clearance must be within specification. Mark piston for proper cylinder location.

### ASSEMBLING PISTON & CONNECTING ROD

Install proper fitted piston on connecting rod for proper cylinder. Ensure piston marking on top of piston marked is in correspondence with connecting rod and cap number. See Fig. 14.

Ensure Piston Floats  
During Installation Operation

Cylinder Number

"FRONT" Indicator  
Of Piston

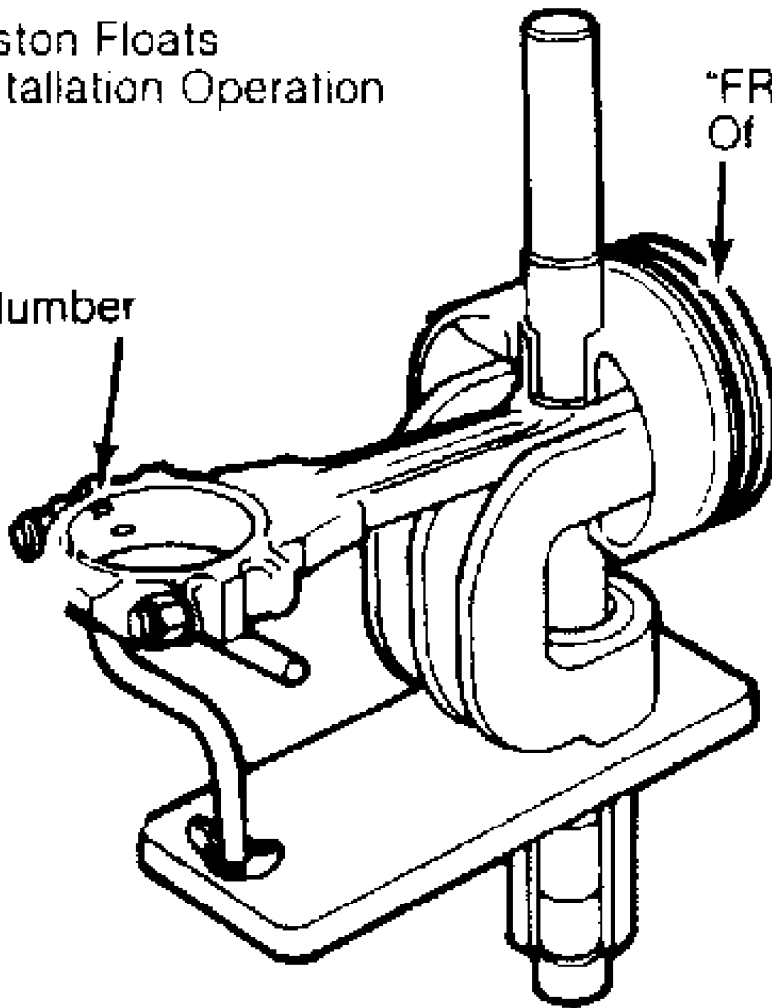


Fig. 14: Piston Pin Installation - Typical  
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Lubricate piston pin and install in connecting rod. Ensure piston pin retainers are fully seated (if equipped). On pressed type piston pins, follow manufacturer's recommended procedure to avoid distortion or breakage.

### CHECKING PISTON RING CLEARANCES

Piston rings must be checked for side clearance and end gap. To check end gap, install piston ring in cylinder which it is to be installed. Using an inverted piston, push ring to bottom of cylinder in smallest cylinder diameter.

Using feeler gauge, check ring end gap. See Fig. 15. Piston ring end gap must be within specification. Ring breakage will occur with insufficient ring end gap.

On some manufacturers, insufficient ring end gap may be corrected by using a fine file while other manufacturers recommend using another ring set. Mark rings for proper cylinder installation after checking end gap.

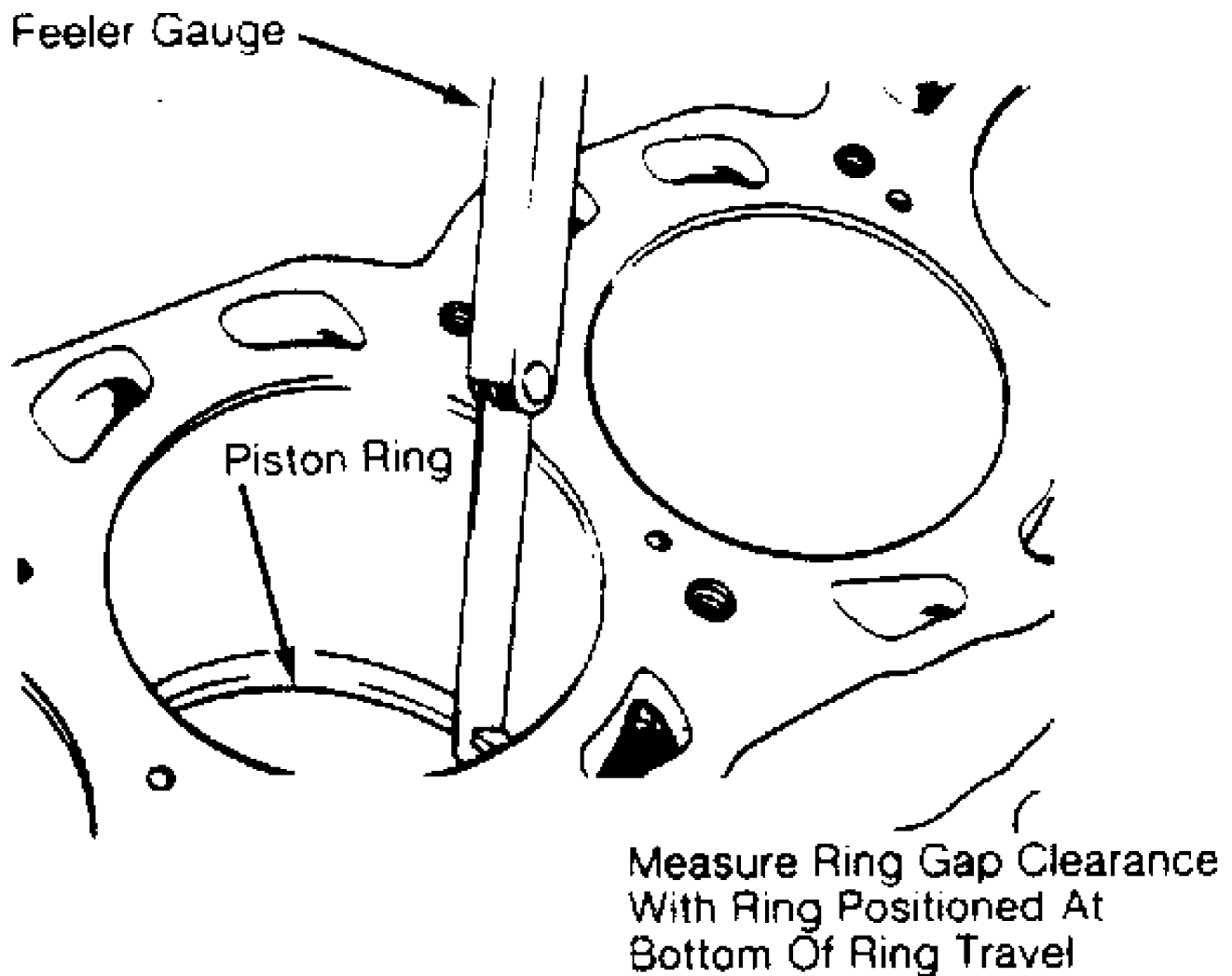


Fig. 15: Checking Piston Ring End Gap - Typical  
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For checking side clearance, install rings on piston. Using feeler gauge, measure clearance between piston ring and piston ring land. Check side clearance in several areas around piston. Side clearance must be within specification.

If side clearance is excessive, piston ring grooves can be machined to accept oversized piston rings (if available). Normal practice is to replace piston.

## PISTON & CONNECTING ROD INSTALLATION

Cylinders must be honed prior to piston installation. See CYLINDER HONING under CYLINDER BLOCK in this article.

Install upper connecting rod bearings. Lubricate upper bearings with engine oil. Install lower bearings in rod caps. Ensure bearing tabs are properly seated. Position piston ring gaps according to manufacturers recommendations. See Fig. 16. Lubricate pistons, rings and cylinder walls.

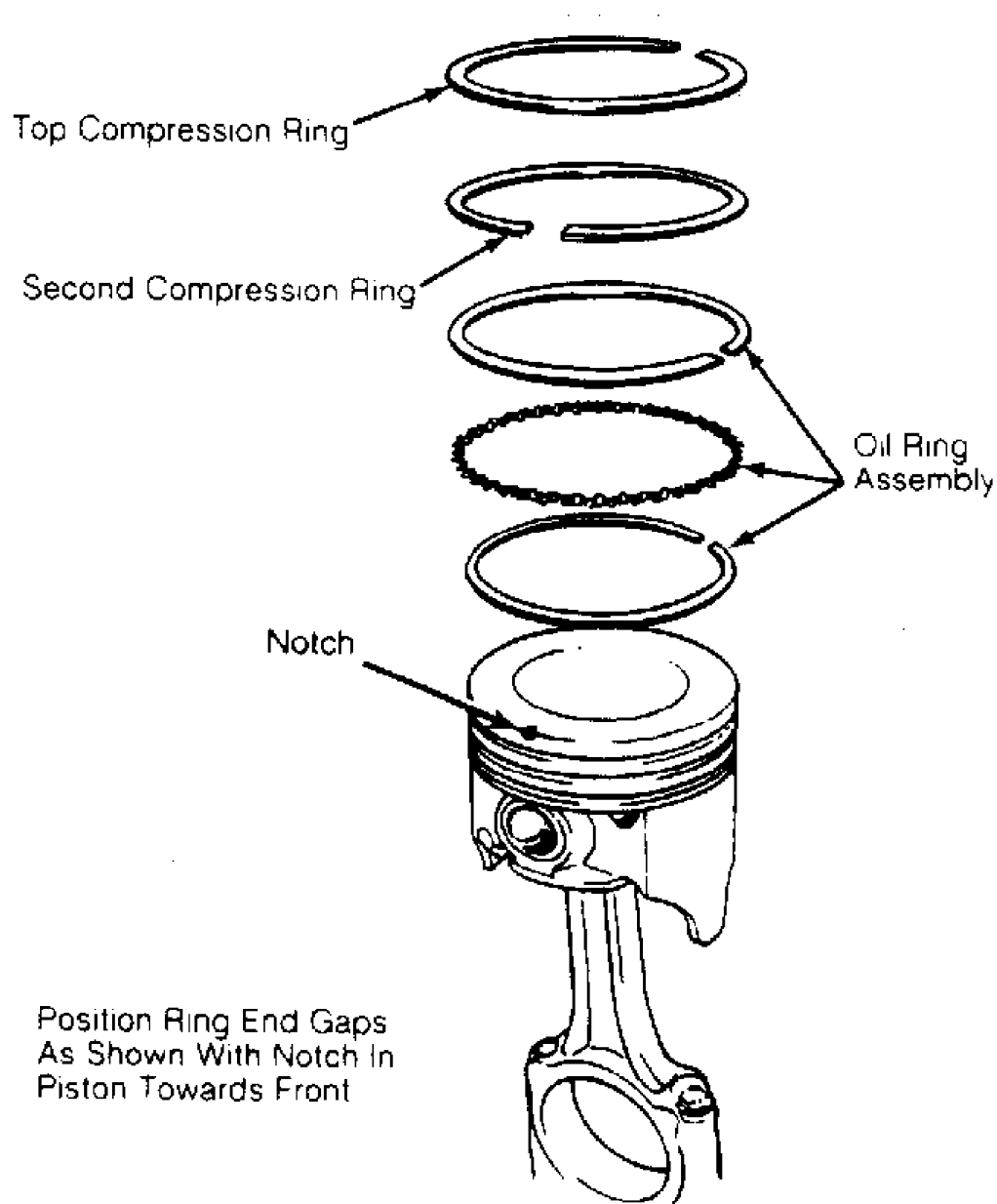


Fig. 16: Typical Piston Ring End Gap Positioning - Typical  
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Install ring compressor. Use care not to rotate piston rings. Compress rings with ring compressor. Install plastic tubing protectors

over connecting rod bolts. Install piston and connecting rod assembly. Ensure piston notch, arrow or "FRONT" mark is toward front of engine. See Fig. 17.

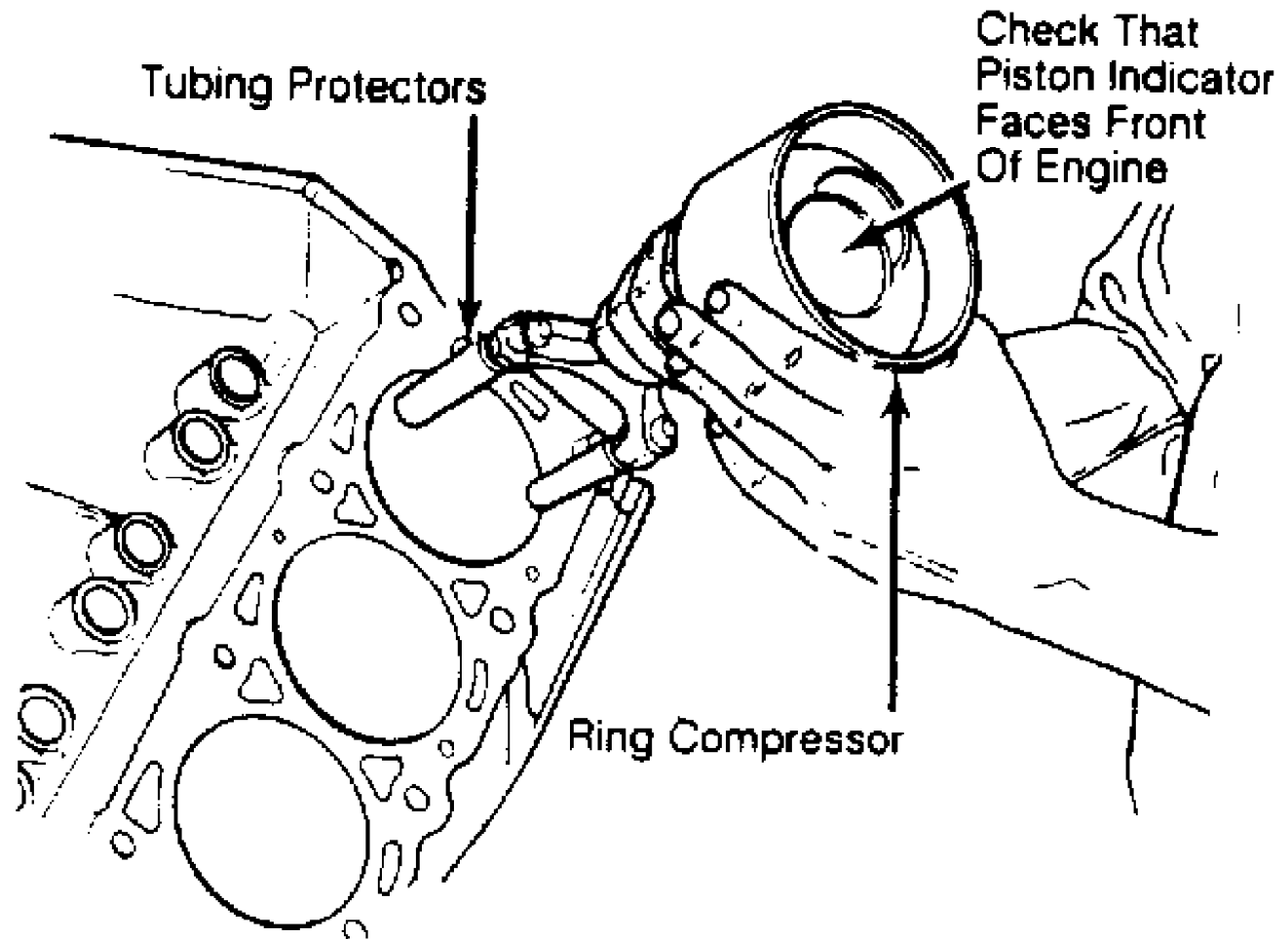


Fig. 17: Installing Piston & Connecting Rod Assembly - Typical  
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Carefully tap piston into cylinder until rod bearing is seated on crankshaft journal. Remove protectors. Install rod cap and bearing. Lightly tighten connecting rod bolts. Repeat procedure for remaining cylinders. Check bearing clearance. See MAIN & CONNECTING ROD BEARING CLEARANCE in this article.

Once clearance is checked, lubricate journals and bearings. Install bearing caps. Ensure marks are aligned on connecting rod and cap. Tighten rod nuts or bolts to specification. Ensure rod moves freely on crankshaft. Check connecting rod side clearance. See CONNECTING ROD SIDE CLEARANCE in this article.

### CONNECTING ROD SIDE CLEARANCE

Position connecting rod toward one side of crankshaft as far as possible. Using feeler gauge, measure clearance between side of connecting rod and crankshaft. See Fig. 18. Clearance must be within specifications.

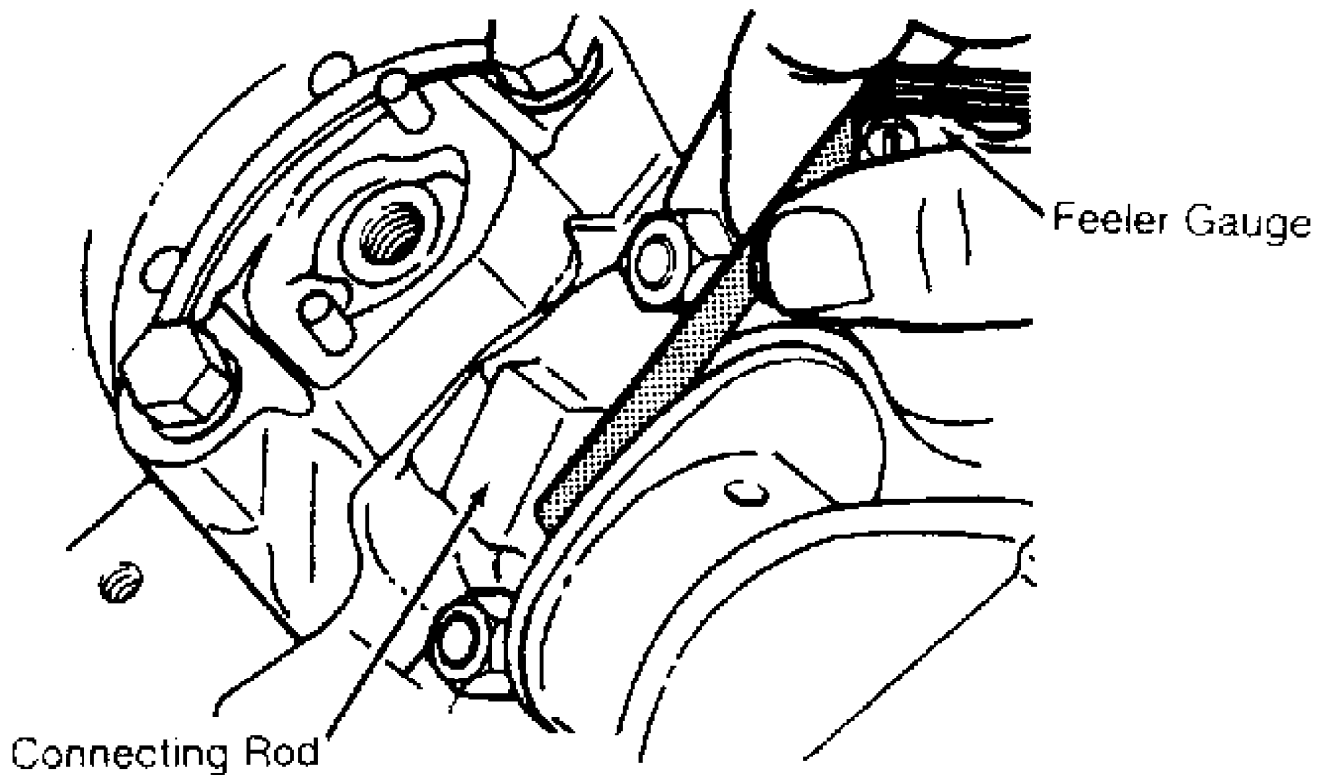


Fig. 18: Measuring Connecting Rod Side Clearance - Typical  
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Check for improper bearing installation, wrong bearing cap or insufficient bearing clearance if side clearance is insufficient. Connecting rod may require machining to obtain proper clearance. Excessive clearance usually indicates excessive wear at crankshaft. Crankshaft must be repaired or replaced.

## MAIN & CONNECTING ROD BEARING CLEARANCE

### Plastigage Method

Plastigage method may be used to determine bearing clearance. Plastigage can be used with an engine in service or during reassembly. Plastigage material is oil soluble.

Ensure journals and bearings are free of oil or solvent. Oil or solvent will dissolve material and false reading will be obtained. Install small piece of Plastigage along full length of bearing journal. Install bearing cap in original location. Tighten bolts to specification.

**CAUTION:** DO NOT rotate crankshaft while Plastigage is installed. Bearing clearance will not be obtained if crankshaft is rotated.

Remove bearing cap. Compare Plastigage width with scale on Plastigage container to determine bearing clearance. See Fig. 19. Rotate crankshaft 90 degrees. Repeat procedure. This is done to check journal eccentricity. This procedure can be used to check oil clearance on both connecting rod and main bearings.

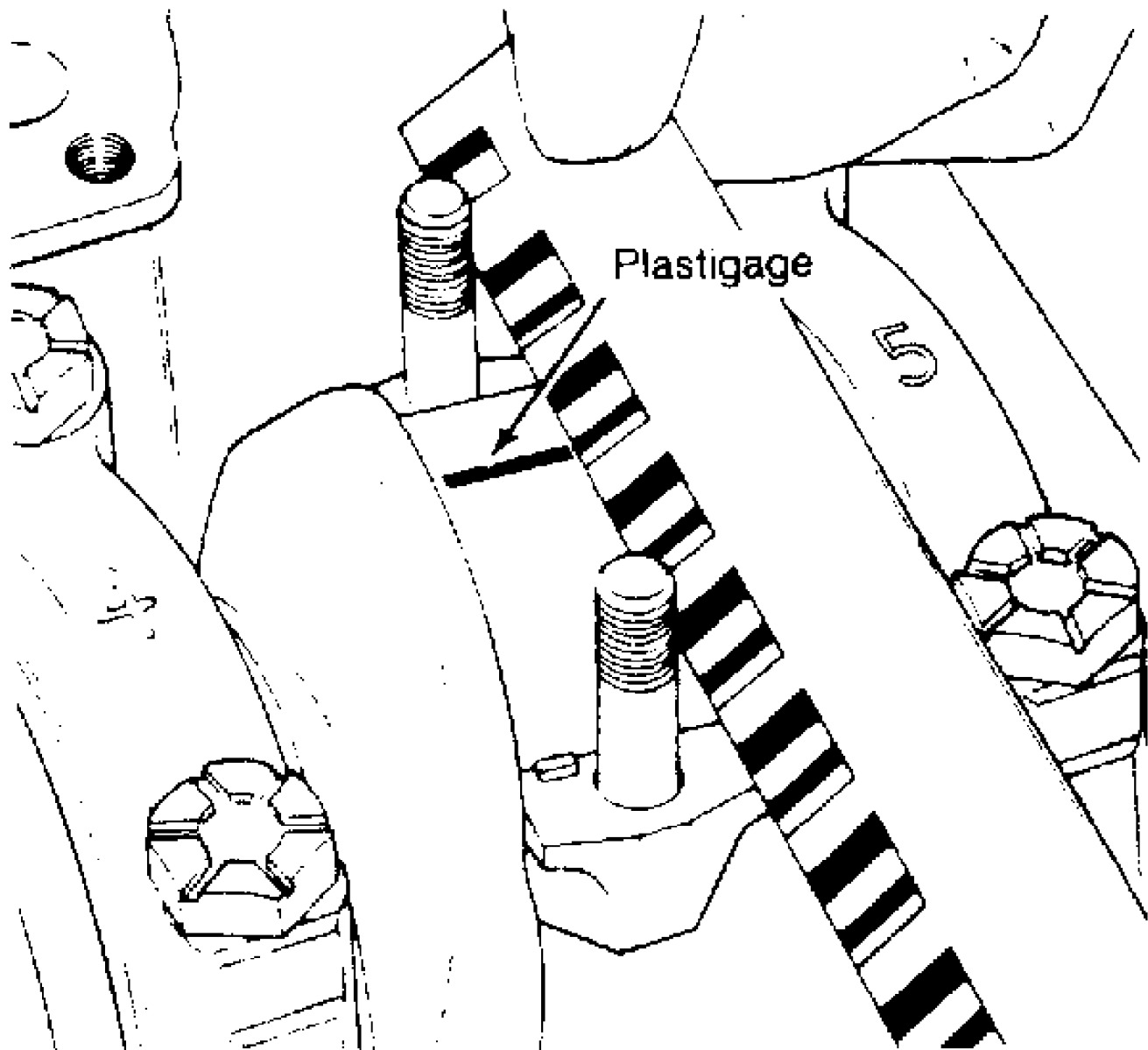


Fig. 19: Measuring Bearing Clearance - Typical  
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#### Micrometer & Telescopic Gauge Method

A micrometer is used to determine journal diameter, taper and out-of-round dimensions of the crankshaft. See **CLEANING & INSPECTION** under **CRANKSHAFT & MAIN BEARINGS** in this article.

With crankshaft removed, install bearings and caps in original location on cylinder block. Tighten bolts to specification. On connecting rods, install bearings and caps on connecting rods. Install proper connecting rod cap on corresponding rod. Ensure bearing cap is installed in original location. Tighten bolts to specification.

Using a telescopic gauge and micrometer or inside micrometer measure inside diameter of connecting rod and main bearings bores. Subtract each crankshaft journal diameter from the corresponding inside bore diameter. This is the bearing clearance.

## CRANKSHAFT & MAIN BEARINGS

### \* PLEASE READ THIS FIRST \*

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

### REMOVAL

Ensure all main bearing caps are marked for location on cylinder block. Some main bearing caps have an arrow stamped on it which must face front of engine. Remove main bearing cap bolts. Remove main bearing caps. Carefully remove crankshaft. Use care not to bind crankshaft in cylinder block during removal.

### CLEANING & INSPECTION

Thoroughly clean crankshaft using solvent. Dry with compressed air. Ensure all oil passages are clear and free of sludge, rust, dirt, and metal chips.

Inspect crankshaft for scoring and nicks. Inspect crankshaft for cracks using Magnaflux procedure. Inspect rear seal area for grooving or damage. Inspect bolt hole threads for damage. If pilot bearing or bushing is used, check pilot bearing or bushing fit in crankshaft. Inspect crankshaft gear for damaged or cracked teeth. Replace gear if damaged. Check that oil passage plugs are tight (if equipped).

Using micrometer, measure all journals in 4 areas to determine journal taper, out-of-round and undersize. See Fig. 20. Some crankshafts can be reground to the next largest undersize, depending on the amount of wear or damage. Crankshafts with rolled fillet cannot be reground and must be replaced.

- A - B = Vertical Taper
- C - D = Horizontal Taper
- A - C & B - D = Out-Of-Round

Check For Out-Of-Round At Each End Of Journal

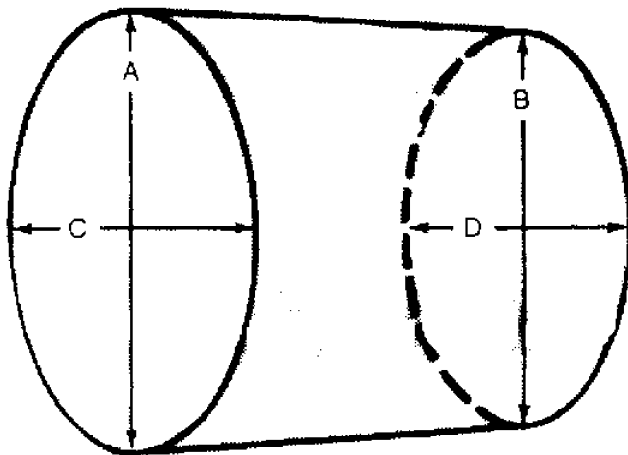


Fig. 20: Measuring Crankshaft Journal - Typical  
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Crankshaft journal runout should be checked. Install crankshaft in "V" blocks or bench center. Position dial indicator

with tip resting on the main bearing journal area. See Fig. 21. Rotate crankshaft and note reading. Journal runout must not exceed specification. Repeat procedure on all main bearing journals. Crankshaft must be replaced if runout exceeds specification.

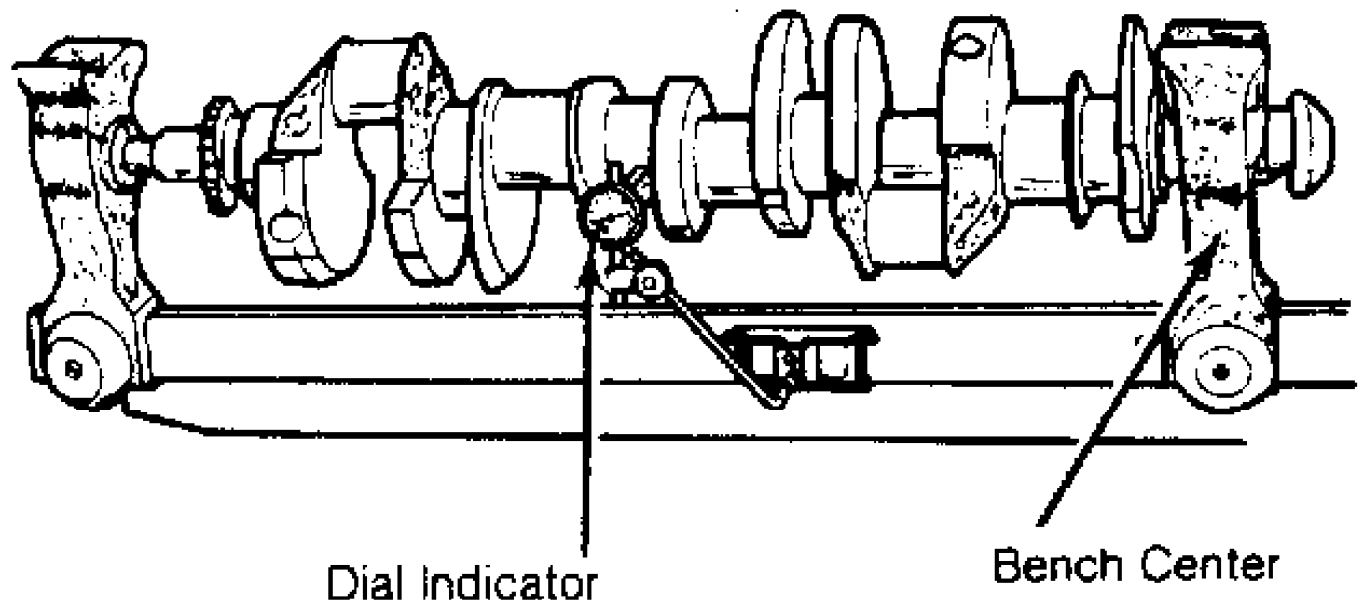


Fig. 21: Measuring Crankshaft Main Bearing Journal Runout - Typical  
This Graphic For General Information Only

## INSTALLATION

Install upper main bearing in cylinder block. Ensure lock tab is properly located in cylinder block. Install bearings in main bearing caps. Ensure all oil passages are aligned. Install rear seal (if removed).

Ensure crankshaft journals are clean. Lubricate upper main bearings with clean engine oil. Carefully install crankshaft. Check each main bearing clearance using Plastigage method. See MAIN & CONNECTING ROD BEARING CLEARANCE in this article.

Once clearance is checked, lubricate lower main bearing and journals. Install main bearing caps in original location. Install rear seal in rear main bearing cap (if removed). Some rear main bearing caps require sealant to be applied in corners to prevent oil leakage.

Install and tighten all bolts except thrust bearing cap to specification. Tighten thrust bearing cap bolts finger tight only. Thrust bearing must be aligned. On most applications, crankshaft must be moved rearward then forward. Procedure may vary with manufacturer. Thrust bearing cap is then tighten to specification. Ensure crankshaft rotates freely. Crankshaft end play should be checked. See CRANKSHAFT END PLAY in this article.

## CRANKSHAFT END PLAY

### Dial Indicator Method

Crankshaft end play can be checked using dial indicator. Mount dial indicator on rear of cylinder block. Position dial indicator tip against rear of crankshaft. Ensure tip is resting against flat surface.

Pry crankshaft rearward. Adjust dial indicator to zero.



Pry crankshaft forward and note reading. Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversized thrust bearings.

#### Feeler Gauge Method

Crankshaft end play can be checked using feeler gauge. Pry crankshaft rearward. Pry crankshaft forward. Using feeler gauge, measure clearance between crankshaft and thrust bearing surface. See Fig. 22.

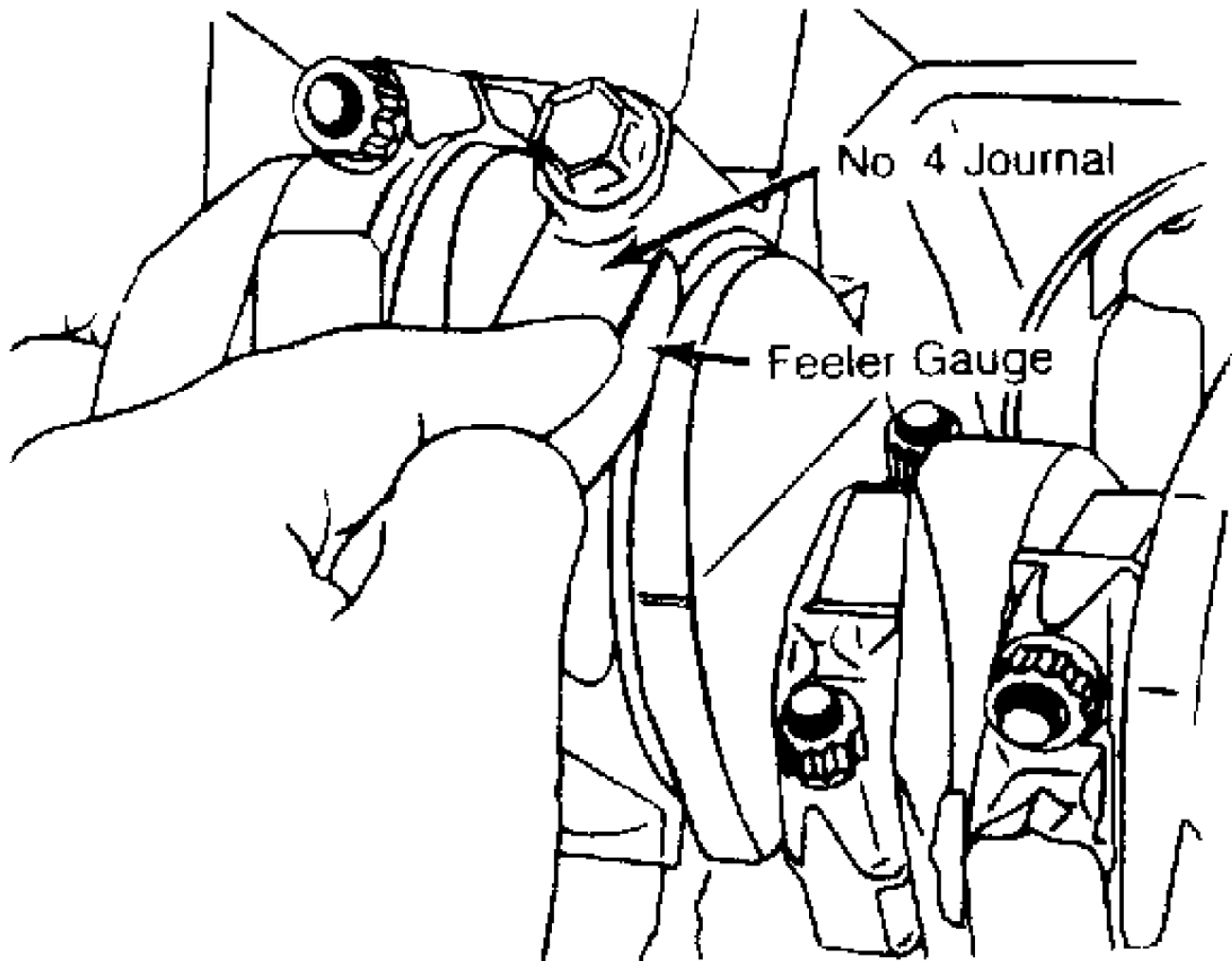


Fig. 22: Checking Crankshaft End Play - Typical  
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Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversized thrust bearings.

## CYLINDER BLOCK

### \* PLEASE READ THIS FIRST \*

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## BLOCK CLEANING

Only cast cylinder blocks should be hot tank cleaned. Aluminum cylinder blocks should be cleaned using cold tank method. Cylinder block is cleaned in order to remove carbon deposits, gasket residue and water jacket scale. Remove oil galley plugs, freeze plugs and cam bearings prior to block cleaning.

## BLOCK INSPECTION

Visually inspect the block. Check suspected areas for cracks using the Dye Penetrant inspection method. Block may be checked for cracks using the Magnaflux method.

Cracks are most commonly found at the bottom of the cylinders, the main bearing saddles, near expansion plugs and between the cylinders and water jackets. Inspect lifter bores for damage. Inspect all head bolt holes for damaged threads. Threads should be cleaned using tap to ensure proper head bolt torque. Consult machine shop concerning possible welding and machining (if required).

## CYLINDER BORE INSPECTION

Inspect the bore for scuffing or roughness. Cylinder bore is dimensionally checked for out-of-round and taper using dial bore gauge. For determining out-of-round, measure cylinder parallel and perpendicular to the block centerline. Difference in the 2 readings is the bore out-of-round. Cylinder bore must be checked at top, middle and bottom of piston travel area.

Bore taper is obtained by measuring bore at the top and bottom. If wear has exceeded allowable limits, block must be honed or bored to next available oversize piston dimension.

## CYLINDER HONING

Cylinder must be properly honed to allow new piston rings to properly seat. Cross-hatching at correct angle and depth is critical to lubrication of cylinder walls and pistons.

A flexible drive hone and power drill are commonly used. Drive hone must be lubricated during operation. Mix equal parts of kerosene and SAE 20w engine oil for lubrication.

Apply lubrication to cylinder wall. Operate cylinder hone from top to bottom of cylinder using even strokes to produce 45 degree cross-hatch pattern on the cylinder wall. DO NOT allow cylinder hone to extend below cylinder during operation.

Recheck bore dimension after final honing. Wash cylinder wall with hot soapy water to remove abrasive particles. Blow dry with compressed air. Coat cleaned cylinder walls with lubricating oil.

## DECK WARPAGE

Check deck for damage or warped head sealing surface. Place a straightedge across gasket surface of the deck. Using feeler gauge, measure clearance at center of straightedge. Measure across width and

length of cylinder block at several points.

If warpage exceeds specifications, deck must be resurfaced. If warpage exceeds manufacturer's maximum tolerance for material removal, replace block.

## **DECK HEIGHT**

Distance from the crankshaft centerline to the block deck is termed the deck height. Measure and record front and rear main journals of crankshaft. To compute this distance, install crankshaft and retain with center main bearing and cap only. Measure distance from the crankshaft journal to the block deck, parallel to the cylinder centerline.

Add one half of the main bearing journal diameter to distance from crankshaft journal to block deck. This dimension should be checked at front and rear of cylinder block. Both readings should be the same.

If difference exceeds specifications, cylinder block must be repaired or replaced. Deck height and warpage should be corrected at the same time.

## **MAIN BEARING BORE & ALIGNMENT**

For checking main bearing bore, remove all bearings from cylinder block and main bearing caps. Install main bearing caps in original location. Tighten bolts to specification. Using inside micrometer, measure main bearing bore in 2 areas 90 degrees apart. Determine bore size and out-of-round. If diameter is not within specification, block must be align-bored.

For checking alignment, place a straightedge along centerline of main bearing saddles. Check for clearance between straightedge and main bearing saddles. Block must be align-bored if clearance is present.

## **EXPANSION PLUG REMOVAL & INSTALLATION**

### **Removal**

Drill a hole in the center of expansion plug. Remove with screwdriver or punch. Use care not to damage sealing surface.

### **Installation**

Ensure sealing surface is free of burrs. Coat expansion plug with sealer. Use a wooden dowel or pipe of slightly smaller diameter, install expansion plug. Ensure expansion plug is evenly located.

## **OIL GALLERY PLUG REMOVAL & INSTALLATION**

### **Removal**

Remove threaded oil gallery plugs using the appropriate wrench. Soft, press-in plugs are removed by drilling into plug and installing a sheet metal screw. Remove plug with slide hammer or pliers.

### **Installation**

Ensure threads or sealing surface is clean. Coat threaded oil gallery plugs with sealer and install. Replacement soft press-in plugs are driven in place with a hammer and drift.

## **CAMSHAFT**

**\* PLEASE READ THIS FIRST \***

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

## CLEANING & INSPECTION

Clean camshaft with solvent. Ensure all oil passages are clear. Inspect cam lobes and bearing journals for pitting, flaking or scoring. Using micrometer, measure bearing journal O.D.

Support camshaft at each end with "V" blocks. Position dial indicator with tip resting on center bearing journal. Rotate camshaft and note reading. If reading exceeds specification, replace camshaft.

Check cam lobe lift by measuring base circle of camshaft using micrometer. Measure again at 90 degrees to tip of cam lobe. Cam lift can be determined by subtracting base circle diameter from tip of cam lobe measurement.

Different lift dimensions are given for intake and exhaust cam lobes. Reading must be within specifications. Replace camshaft if cam lobes or bearing journals are not within specifications.

Inspect camshaft gear for chipped, eroded or damaged teeth. Replace gear if damaged. On camshafts using thrust plate, measure distance between thrust plate and camshaft shoulder. Replace thrust plate if not within specification.

## CAMSHAFT BEARINGS

### Removal & Installation

Remove the camshaft rear plug. The camshaft bearing remover is assembled with its shoulder resting on the bearing to be removed according to manufacturer's instructions. Tighten puller nut until bearing is removed. Remove remaining bearings, leaving front and rear bearings until last. These bearings act as guide for camshaft bearing remover.

To install new bearings, puller is rearranged to pull bearings toward the center of block. Ensure all lubrication passages of bearing are aligned with cylinder block. Coat new camshaft rear plug with sealant. Install camshaft rear plug. Ensure plug is even in cylinder block.

## CAMSHAFT INSTALLATION

Lubricate bearing surfaces and cam lobes with ample amount of Molykote or camshaft lubricant. Carefully install camshaft. Use care not to damage bearing journals during installation. Install thrust plate retaining bolts (if equipped). Tighten bolts to specification. On overhead camshafts, install bearing caps in original location. Tighten bolts to specification. Check end play.

## CAMSHAFT END PLAY

Using dial indicator, check end play. Position dial indicator on front of engine block. Position indicator tip against camshaft. Push camshaft toward rear of engine and adjust indicator to zero.

Move camshaft forward and note reading. Camshaft end play must be within specification. End play may be adjusted by relocating gear, shimming thrust plate or replacing thrust plate depending on manufacturer.

## TIMING CHAINS & BELTS

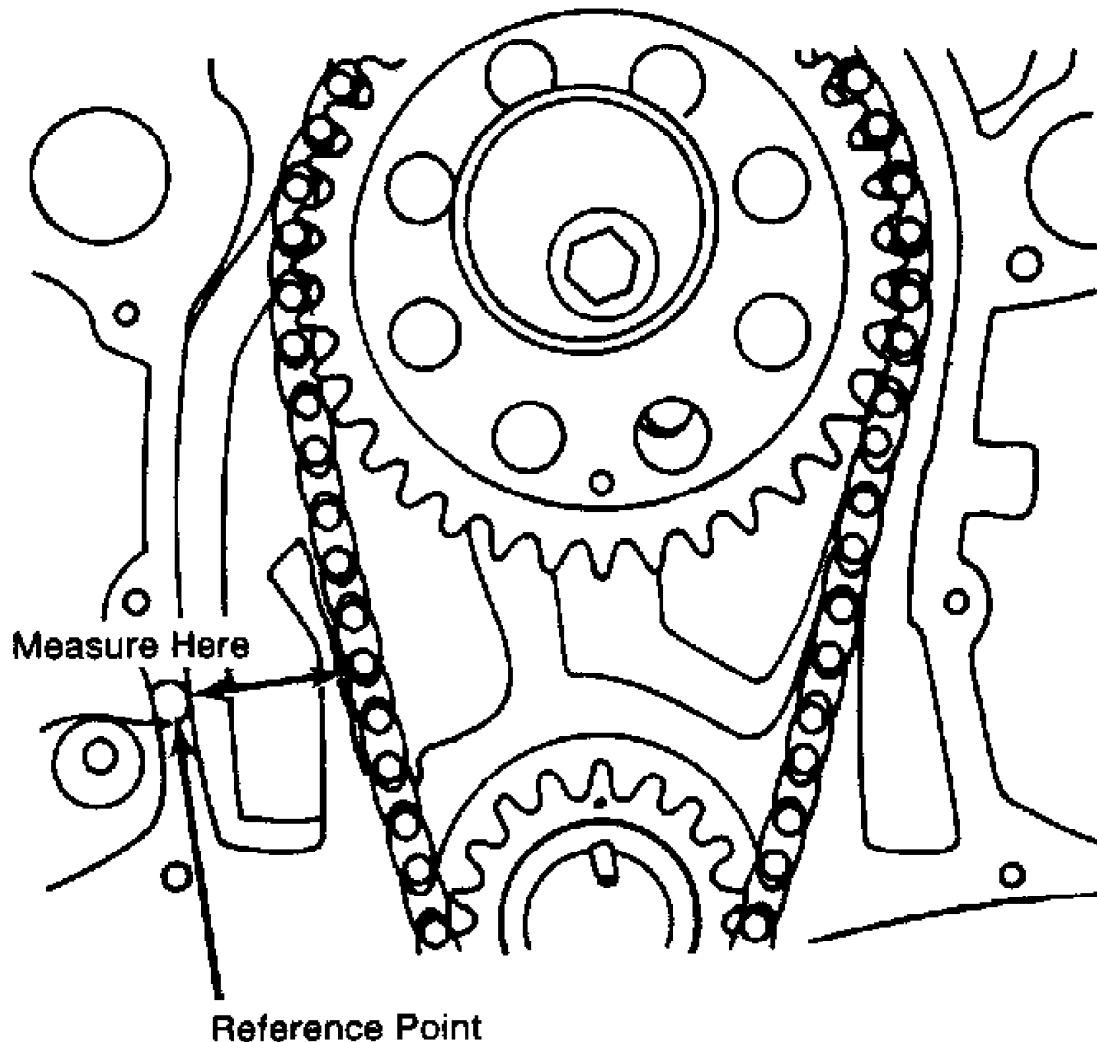
**\* PLEASE READ THIS FIRST \***

**NOTE:** Always refer to appropriate engine overhaul article in the **ENGINES** section for complete overhaul procedures and specifications for the vehicle being repaired.

## **TIMING CHAINS**

Timing chains will stretch during operation. Limits are placed upon amount of stretch before replacement is required. Timing chain stretch will alter ignition timing and valve timing.

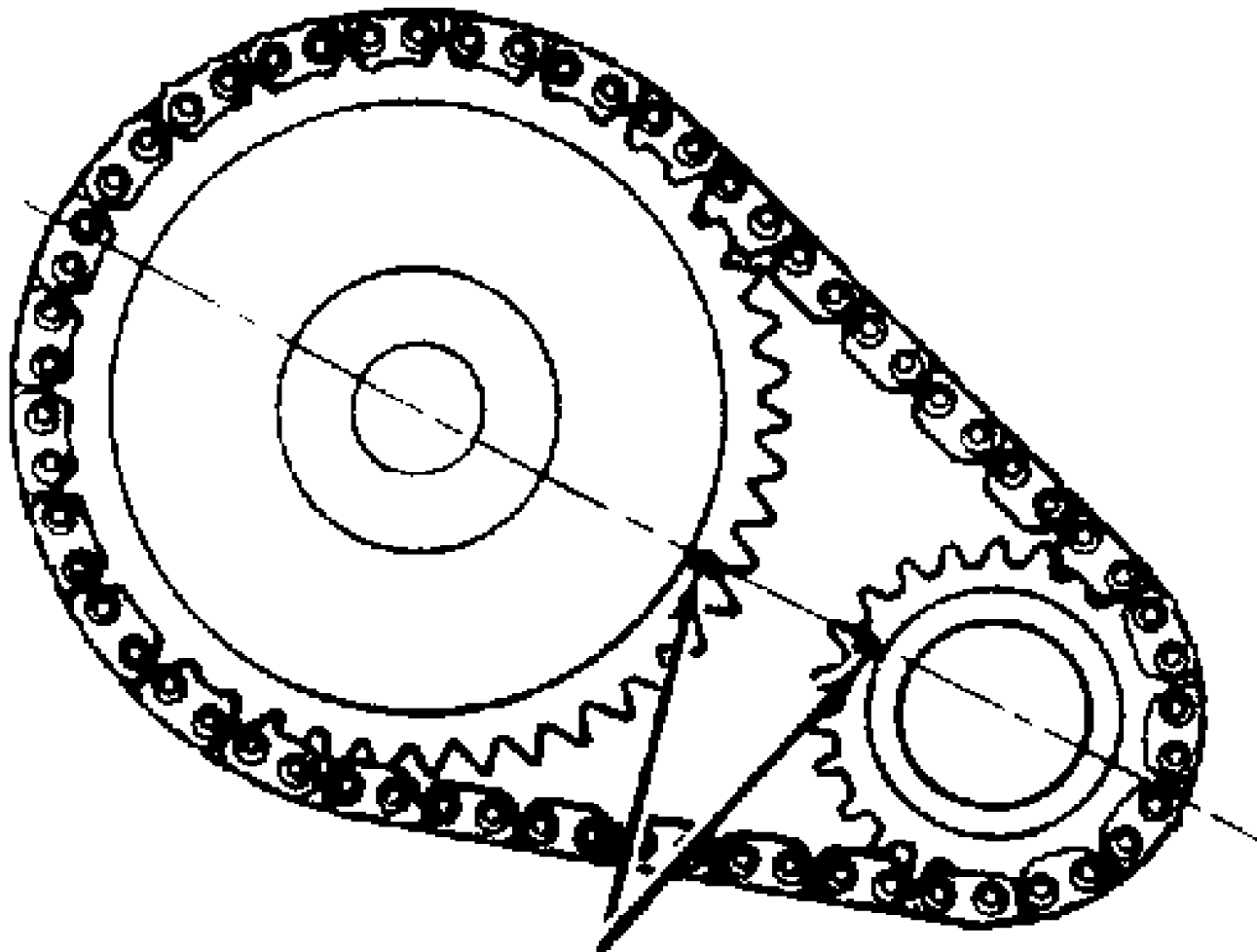
To check timing chain stretch, rotate crankshaft to eliminate slack from one side of timing chain. Mark reference point on cylinder block. Rotate crankshaft in opposite direction to eliminate slack from remaining side of timing chain. Force other side of chain outward and measure distance between reference point and timing chain. See Fig. 23. Replace timing chain and gears if not within specification.



**Fig. 23: Measuring Timing Chain Stretch - Typical**  
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Timing chains must be installed so that timing marks on camshaft gear and crankshaft gear are aligned according to

manufacturer. See Fig. 24.



## Timing Marks

Fig. 24: Timing Gear Mark Alignment - Typical  
This Graphic For General Information Only

### TIMING BELTS

Cogged tooth belts are commonly used on overhead cam engines. Inspect belt teeth for rounded corners or cracking. Replace belt if cracked, damaged, missing teeth or oil soaked.

Used timing belt must be installed in original direction of rotation. Inspect all sprocket teeth for wear. Replace all worn sprockets. Sprockets are marked for timing purposes. Engine is positioned so that crankshaft sprocket mark will be upward. Camshaft sprocket is aligned with reference mark on cylinder head and timing belt is installed. See Fig. 25.

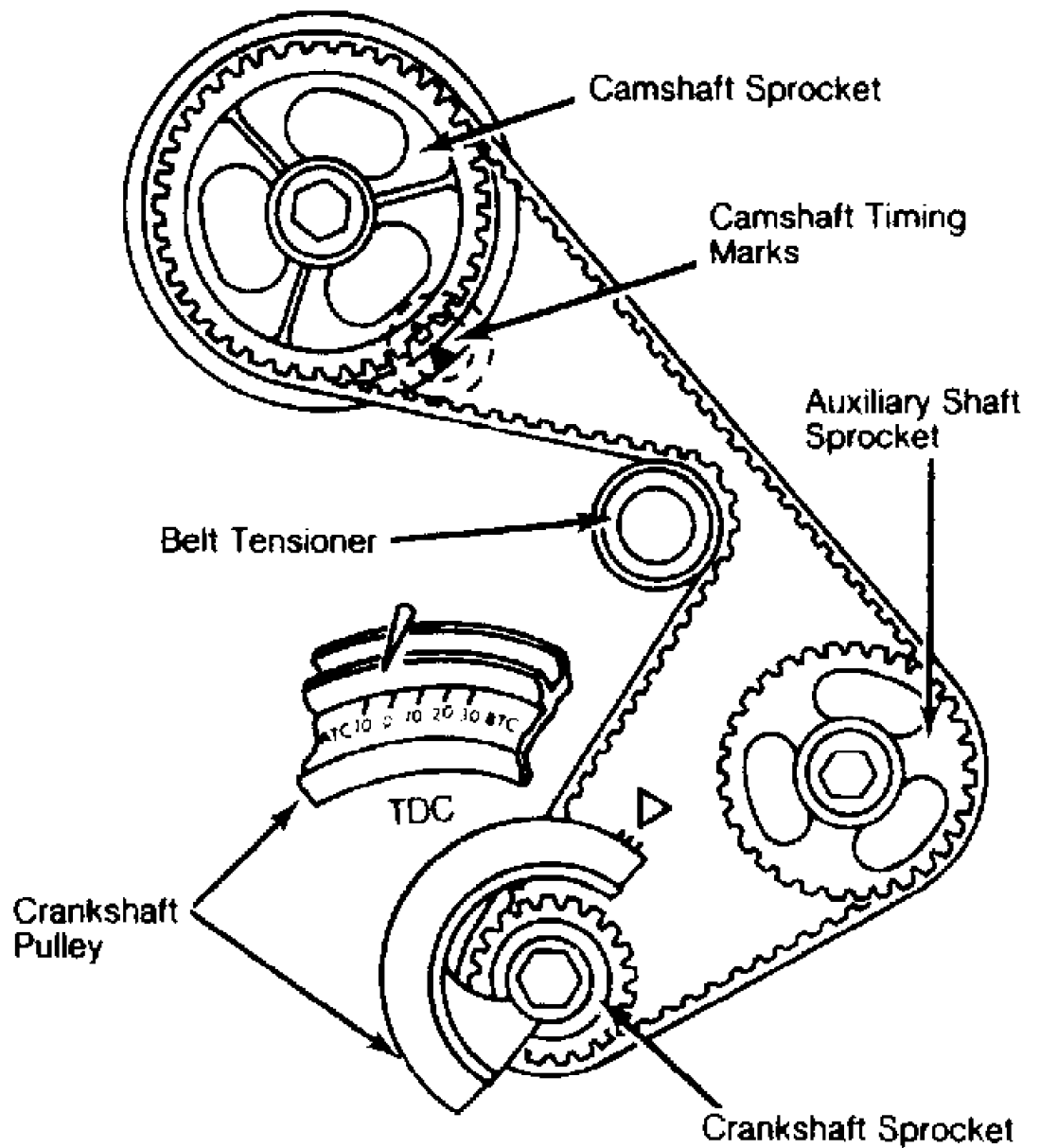


Fig. 25: Timing Belt Sprocket Alignment - Typical  
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## TENSION ADJUSTMENTS

If guide rails are used with spring loaded tensioners, ensure at least half of original rail thickness remains. Spring loaded tensioner should be inspected for damage.

Ensure all timing marks are aligned. Adjust belt tension using manufacturer's recommendations. Belt tension may require checking using tension gauge. See Fig. 26.

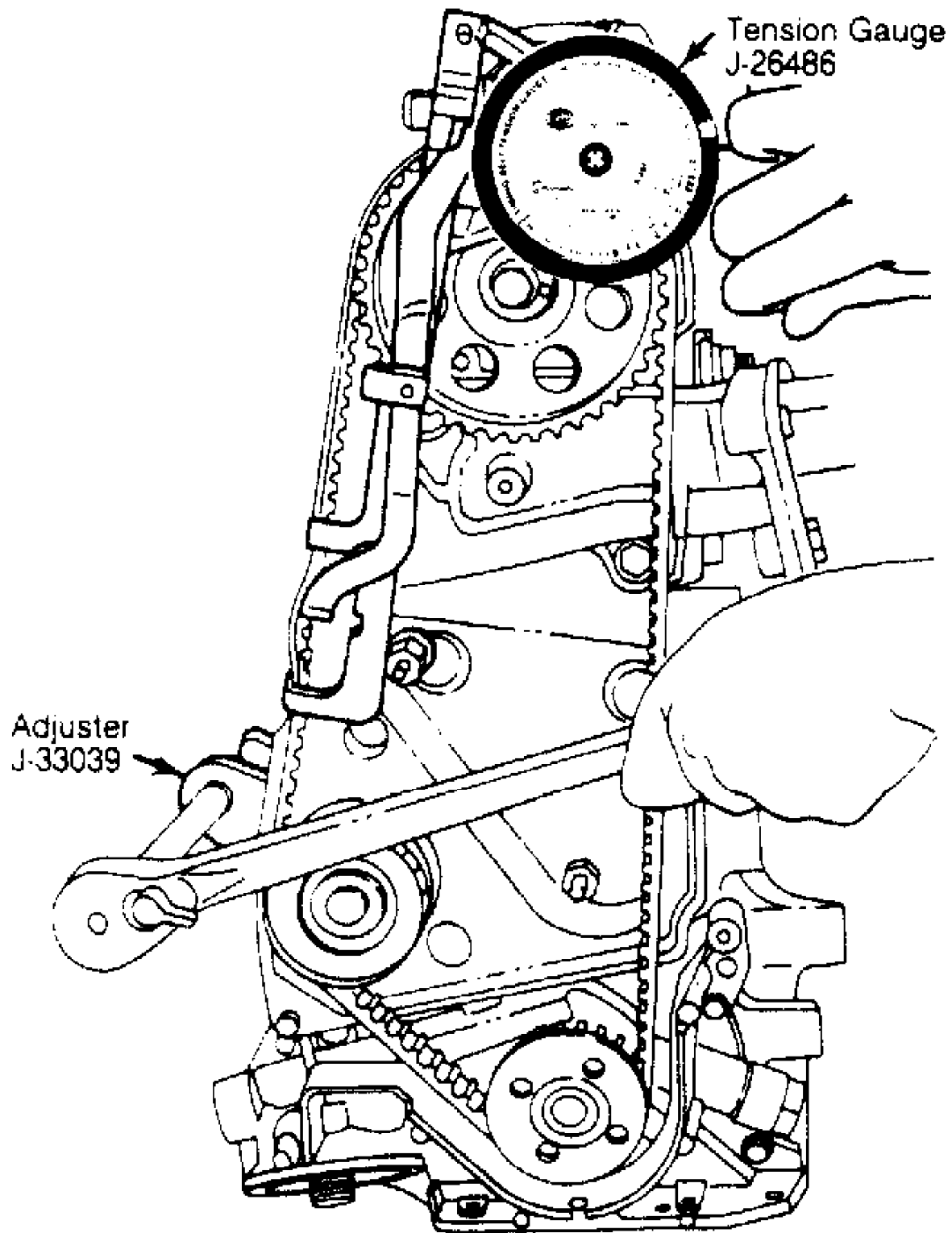


Fig. 26: Timing Belt Tension Adjustment - Typical  
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## TIMING GEARS



**\* PLEASE READ THIS FIRST \***

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

**TIMING GEAR BACKLASH & RUNOUT**

On engines where camshaft gear operates directly on crankshaft gear, gear backlash and runout must be checked. To check backlash, install dial indicator with tip resting on tooth of camshaft gear. Rotate camshaft gear as far as possible. Adjust indicator to zero. Rotate camshaft gear in opposite direction as far as possible and note reading.

To determine timing gear runout, mount dial indicator with tip resting on face edge of camshaft gear. Adjust indicator to zero. Rotate camshaft gear 360 degrees and note reading. If backlash or runout exceed specifications, replace camshaft and/or crankshaft gear.

**REAR MAIN OIL SEAL**

**\* PLEASE READ THIS FIRST \***

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

**INSTALLATION**

**One-Piece Type Seal**

For one-piece type oil seal installation, coat block contact surface of seal with sealer if seal is not factory coated. Ensure seal surface is free of burrs. Lubricate seal lip with engine oil and press seal into place using proper oil seal installer. See Fig. 27.

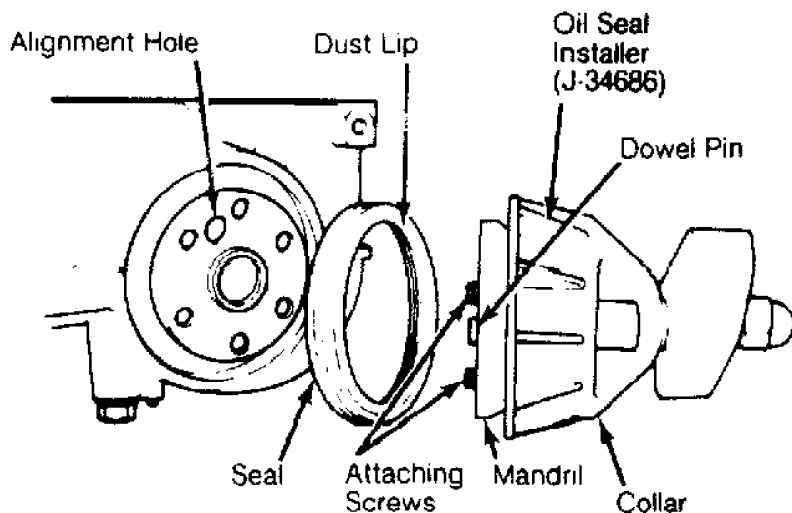


Fig. 27: Installing Typical One-Piece Oil Seal  
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**Rope Type Seal**

For rope type rear main oil seal installation, press seal

lightly into its seat. Using seal installer, fully seat seal in bearing cap or cylinder block.

Trim seal ends even with block parting surface. Some applications require sealer to be applied on main bearing cap prior to installation. See Fig. 28.

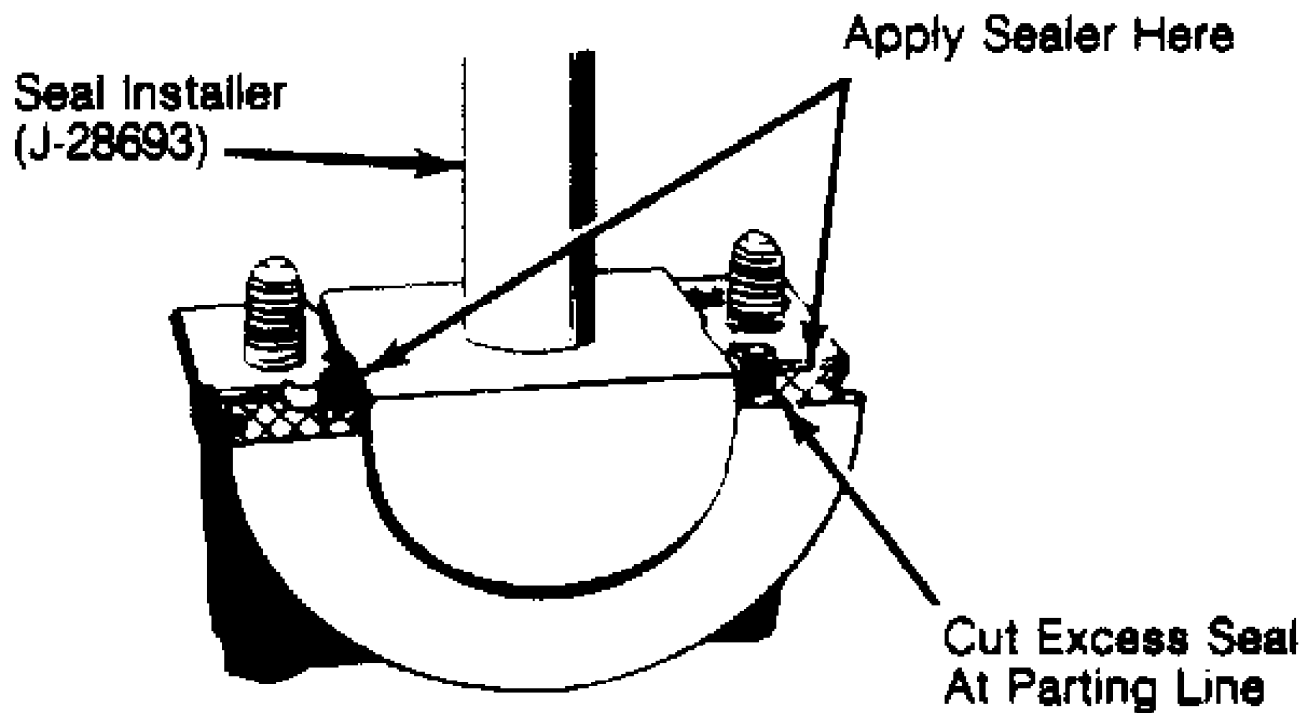


Fig. 28: Typical Rope Seal Installation  
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#### Split-Rubber Type Seal

Follow manufacturers procedures when installing split-rubber type rear main oil seals. Installation procedures vary with engine type. See appropriate ENGINE article in this section. See Fig. 29.

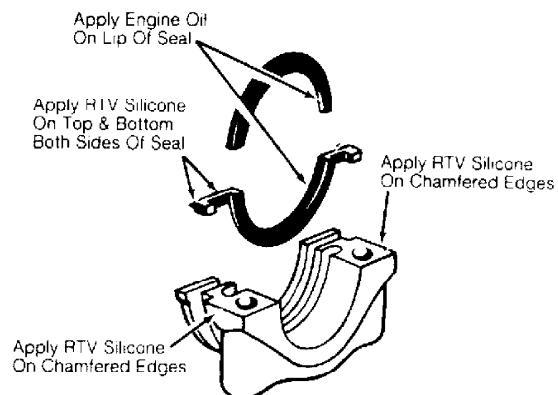


Fig. 29: Typical Split-Rubber Seal Installation  
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## OIL PUMP

**\* PLEASE READ THIS FIRST \***

**NOTE:** Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

**ROTOR-TYPE**

Oil pump rotors must be marked for location prior to removal. See Fig. 30. Remove outer rotor and measure thickness and diameter. Measure inner rotor thickness. Inspect shaft for scoring or wear. Inspect rotors for pitting or damage. Inspect cover for grooving or wear. Replace components if worn or damaged.

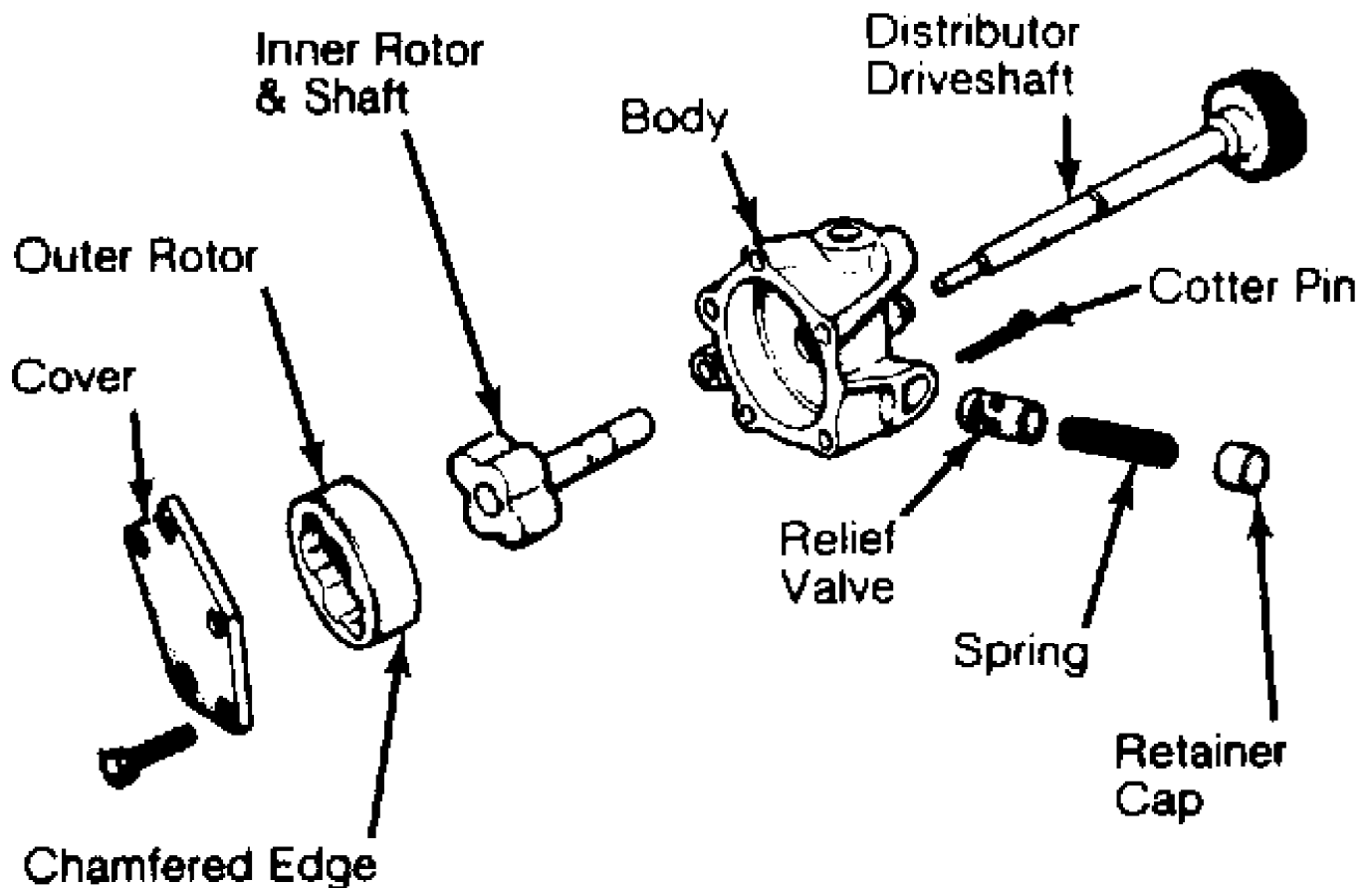


Fig. 30: Typical Rotor Type Oil Pump  
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Measure outer rotor-to-body clearance. Replace pump assembly if clearance exceeds specification. Measure clearance between rotors. See Fig. 31. Replace shaft and both rotors if clearance exceeds specifications.

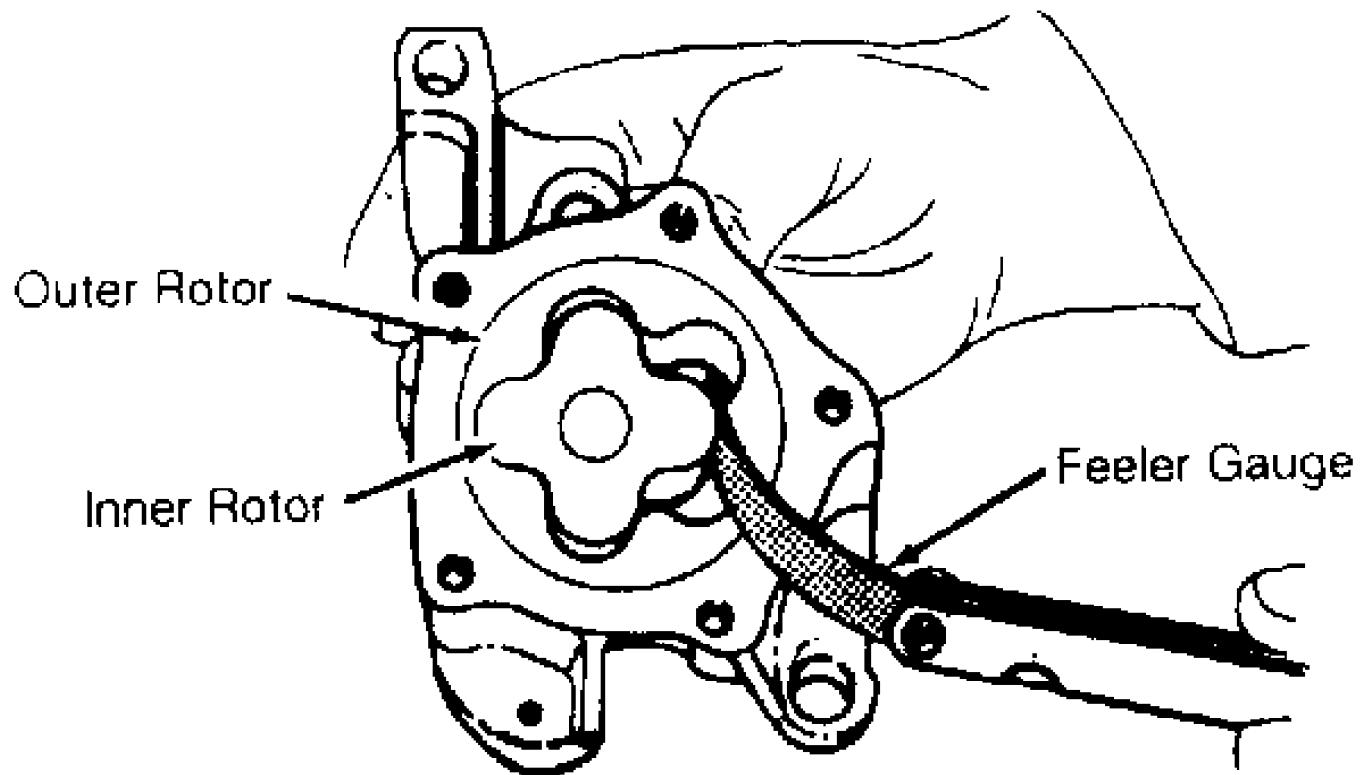


Fig. 31: Measuring Rotor Clearance - Typical  
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Install rotors in pump body. Position straightedge across pump body. Using feeler gauge, measure clearance between rotors and straightedge. Pump cover wear is measured using a straightedge and feeler gauge. Replace pump if clearance exceeds specification.

## GEAR TYPE

Oil pump gears must be marked for location prior to removal. See Fig. 32. Remove gears from pump body. Inspect gears for pitting or damage. Inspect cover for grooving or wear.

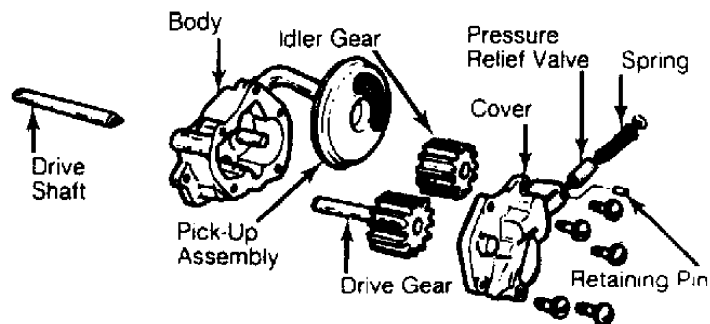


Fig. 32: Typical Gear Type Oil Pump  
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Measure gear diameter and length. Measure gear housing cavity depth and diameter. See Fig. 33. Replace components if worn or

damaged.

Pump cover wear is measured using a straightedge and feeler gauge. Pump is to be replaced if warpage or wear exceeds specifications or mating surface of pump cover is scratched or grooved.

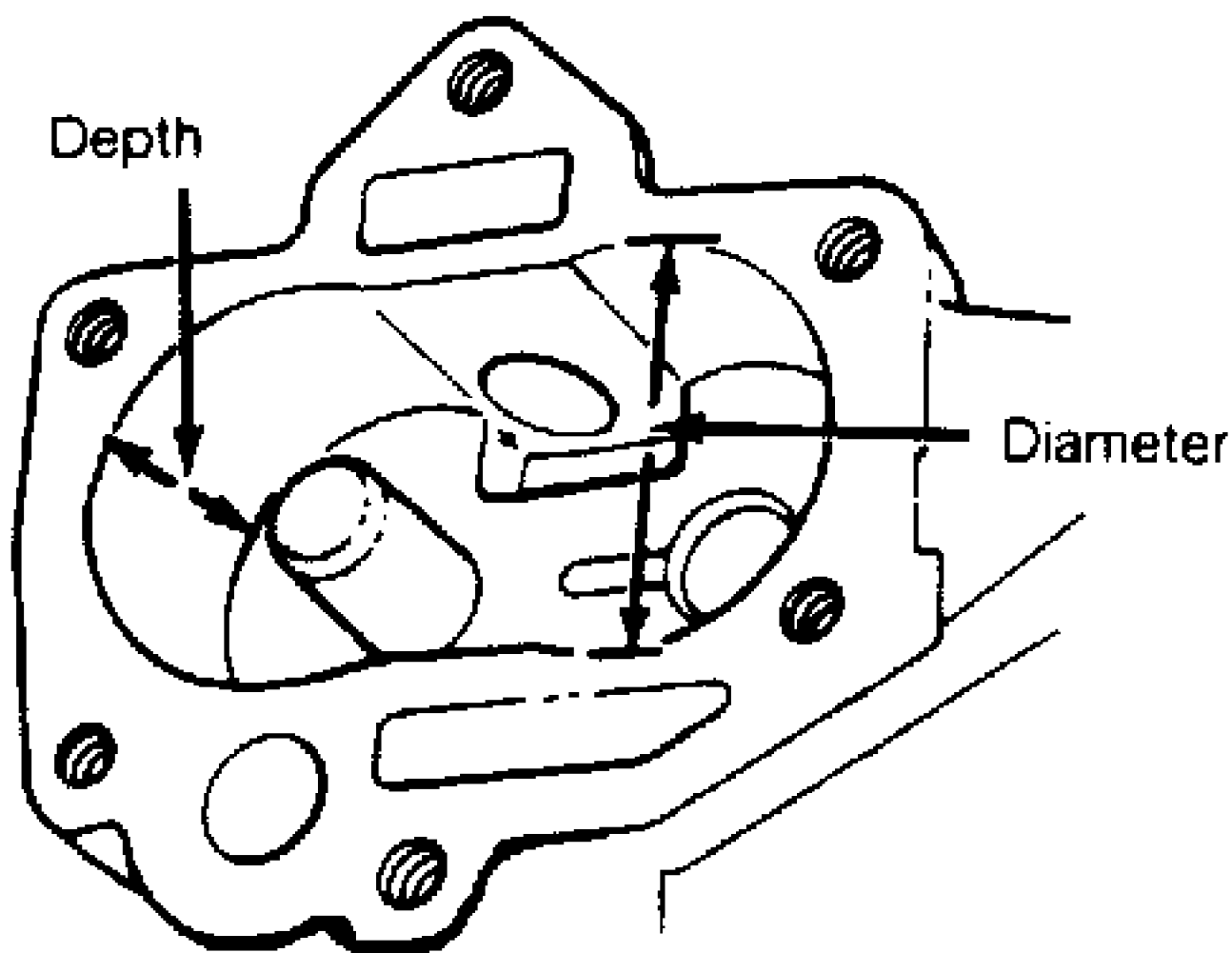


Fig. 33: Measuring Oil Pump Gear Cavity - Typical  
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### **BREAK-IN-PROCEDURE**

\* PLEASE READ THIS FIRST \*

NOTE: Always refer to appropriate engine overhaul article in the  
ENGINES section for complete overhaul procedures and  
specifications for the vehicle being repaired.

### **ENGINE PRE-OILING**

Engine pre-oiling should be done prior to operation to  
prevent engine damage. A lightly oiled pump will cavitate unless oil  
pump cavities are filled with engine oil or petroleum jelly.

Engine pre-oiling can be done using pressure oiler (if available). Connect pressure oiler to cylinder block oil passage such as oil pressure sending unit. Operate pressure oiler long enough to ensure correct amount of oil has filled crankcase. Check oil level while pre-oiling.

If pressure oiler is not available, disconnect ignition system. Remove oil pressure sending unit and replace with oil pressure test gauge. Using starter motor, rotate engine starter until gauge shows normal oil pressure for several seconds. DO NOT crank engine for more than 30 seconds to avoid starter motor damage.

Ensure oil pressure has reached the most distant point from the oil pump. Reinstall oil pressure sending unit. Reconnect ignition system.

## **INITIAL START-UP**

Start the engine and operate engine at low speed while checking for coolant, fuel and oil leaks. Stop engine. Recheck coolant and oil level. Adjust if necessary.

## **CAMSHAFT**

Break-in procedure is required when a new or reground camshaft has been installed. Operate and maintain engine speed between 1500-2500 RPM for approximately 30 minutes. Procedure may vary due to manufacturers recommendations.

## **PISTON RINGS**

Piston rings require a break-in procedure to ensure seating of rings to cylinder walls. Serious damage may occur to rings if correct procedures are not followed.

Extremely high piston ring temperatures are produced obtained during break-in process. If rings are exposed to excessively high RPM or high cylinder pressures, ring damage can occur. Follow piston ring manufacturer's recommended break-in procedure.

## **FINAL ADJUSTMENTS**

Check or adjust ignition timing and dwell (if applicable). Adjust valves (if necessary). Adjust carburetion or injection idle speed and mixture. Retighten cylinder heads (if required). If cylinder head or block is aluminum, retighten bolts when engine is cold. Follow the engine manufacturer's recommended break-in procedure and maintenance schedule for new engines.

**NOTE:** Some manufacturer's require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

# **\* ENGINE SYSTEMS UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

Engine Performance and Maintenance Motorist Assurance Program  
Standards For Automotive Repair

All Makes and Models

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

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FUEL LEVEL SENDERS<sup>7</sup>  
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FUEL RESTRICTORS



FUEL TANKS  
GAS CAPS  
GASKETS  
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HARMONIC DAMPERS  
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HOSE CONNECTORS  
HOSE COUPLERS  
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IDLE SPEED CONTROL ACTUATORS  
IGNITION BOOTS  
IGNITION COIL TOWERS  
IGNITION COILS  
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OIL PUMP PICK-UP SCREENS  
OIL PUMPS  
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PCV BREATHER ELEMENTS  
PCV ORIFICES  
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PICK-UP ASSEMBLIES (INCLUDES MAGNETIC, HALL EFFECT AND  
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POWERTRAIN CONTROL PROM  
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THERMAL VACUUM VALVES  
THERMOSTATIC AIR DOOR ASSEMBLIES  
THERMOSTATS AND HOUSINGS  
THROTTLE BODIES  
THROTTLE CABLES  
THROTTLE LINKAGES AND CABLES  
THROTTLE POSITION SENSORS  
THROTTLE POSITION SWITCHES  
TIMING BELT SPROCKETS  
TIMING BELTS  
TORQUE STRUTS  
TRANSMISSION RANGE SWITCHES  
TUBE CLAMPS  
TUBE CONNECTORS  
TUBE COUPLERS  
TUBES  
TURBO CHARGERS  
VACUUM CONNECTIONS  
VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC)  
VACUUM REGULATOR SOLENOIDS  
VACUUM TUBES  
VEHICLE SPEED SENSORS  
VOLUME AIR FLOW SENSORS  
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WIRING HARNESSSES AND CONNECTORS

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW OF MOTORIST ASSURANCE PROGRAM**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles-through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication

Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

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## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS AND SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is

required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

Example:

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

Example:

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

#### Reasons to Suggest Repair or Replacement

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

### ENGINE ASSEMBLIES

#### SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

#### CYLINDER HEAD ASSEMBLIES

NOTE: A Cylinder Head Assembly is a cylinder head fitted with valves, associated springs, retainers, and on overhead camshaft cylinder heads (OHC), camshaft, camshaft bearings, lash adjusters, tappets and rockers.

#### CYLINDER HEAD ASSEMBLY INSPECTION

Condition	Code	Procedure
Adjustable valve lash is out of specification	... B	..... Require repair.
Internal component failure (any component)	..... A	..... (1) Require repair or replacement of cylinder head assembly.

- (1) - It is Required that all other failure related components be inspected for cause and condition. Additional components or assemblies may be Suggested for repair or replacement, such as a water pump on a short block (reason code 4, technician's recommendation based on substantial and informed experience).

#### Example:

If there is a failed head gasket with an external coolant leak, in addition to Requiring replacement of the head gasket, inspection of the following for cause and condition is Required: Block, Cooling System, Cylinder Head. It may be Suggested that additional inspections be performed, such as the other head gasket on a V-type engine.

### LONG BLOCK ASSEMBLIES

NOTE: A Long Block Assembly is a short block assembly together with a cylinder head assembly and all those components fitted within the rocker or cam cover, and timing cover

(the whole presented as an assembly). A rebuilt or new oil pump, or kit shall be supplied or fitted as appropriate.

#### LONG BLOCK ASSEMBLY INSPECTION

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Condition	Code	Procedure
Internal component failure (any component) .....	A .....	(1) Require repair or replacement of the long block assembly.

- (1) - It is Required that all other failure related components be inspected for cause and condition. Additional components or assemblies may be Suggested for repair or replacement such as a water pump on a short block (reason code 4, technician's recommendation based on substantial and informed experience).

##### Example:

If there is a failed head gasket with an external coolant leak, in addition to Requiring replacement of the head gasket, inspection of the following for cause and condition is Required: Block, Cooling System, Cylinder Head. It may be Suggested that additional inspections be performed, such as the other head gasket on a V-type engine.

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#### SHORT BLOCK ASSEMBLIES

NOTE: A Short Block Assembly is a cylinder block and all those components contained within the limits of the block deck or decks, the pan rail, the block rear face and the timing cover (where fitted), including the crankshaft.

#### SHORT BLOCK ASSEMBLY INSPECTION

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Condition	Code	Procedure
Any internal component failure .....	A .....	(1) Require repair or replacement of the short block assembly.

- (1) - It is Required that all other failure related components be inspected for cause and condition. Additional components or assemblies may be Suggested for repair or replacement, such as a water pump on a short block (reason code 4, technician's recommendation based on substantial and informed experience).

##### Example:

If there is a failed head gasket with an external coolant leak, in addition to Requiring replacement of the head gasket, inspection of the following for cause and condition is Required: Block, Cooling System, Cylinder Head. It may be Suggested that additional inspections be performed, such as the other head gasket on a V-type engine.

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## ENGINE COMPONENTS

### ACCELERATOR PEDAL POSITION SENSORS

#### ACCELERATOR PEDAL POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	B .....	(2) Require repair or replacement. Further inspection required.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## ACCESSORY BELTS

#### ACCESSORY BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B .....	(1) Further inspection required.
Cracked .....	1 .....	Suggest replacement.
Frayed .....	1 .....	Suggest replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 .....	(2) Further inspection required.
Plies separated .....	A .....	Require replacement.
Tension out of specification .....	B .....	Require adjustment or replacement.
Worn beyond adjustment range .....	B .....	Require replacement.
Worn so it contacts bottom of pulley .....	A .....	Require replacement.
(1) - Determine cause of incorrect alignment and require repair.		
(2) - Determine cause of noise and suggest repair.		

## ACCESSORY PULLEYS

### ACCESSORY PULLEY INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bent .....	A .....	Require replacement.
Cracked .....	A .....	Require replacement.
Loose .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Pulley damaged, affecting belt life .....	A .....	Require replacement.

## ACTUATORS

See SENSORS AND ACTUATORS.

## AIR CONDITIONING CYCLING SWITCHES

### AIR CONDITIONING CYCLING SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.



Attaching hardware threads stripped (threads missing) .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Contaminated .....	A	.....	(2) Require repair or replacement.
Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## AIR CONDITIONING PRESSURE SENSORS

### AIR CONDITIONING PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.

Attaching hardware threads damaged .....	A	...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Contaminated .....	A	.....	(2) Require repair or replacement.
Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## AIR DUCTS AND TUBES

### AIR DUCT AND TUBE INSPECTION

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Condition	Code	Procedure
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Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.

## AIR FILTER ELEMENTS

### AIR FILTER ELEMENT INSPECTION

Condition	Code	Procedure
Leaking .....	A	..... Require replacement.
Paper filter element oil-soaked .....	A	..... (1) Require replacement.
Maintenance intervals ...	3	... Suggest replacement to comply with vehicle's OEM recommended service intervals.
Melted .....	A	..... Required replacement.
Missing .....	C	..... Require replacement.
Restricted, affecting performance .....	A	..... Require replacement.
Water-contaminated .....	A	..... (1) Require replacement.

(1) - Further inspection required to determine cause.

## AIR FILTER GASKETS

See AIR FILTER HOUSINGS AND GASKETS.

## AIR FILTER HOUSINGS AND GASKETS

### AIR FILTER HOUSING AND GASKET INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.

## AIR FUEL RATIO SENSORS

# AIR FUEL RATIO SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## AIR INJECTION CONTROL SOLENOIDS

### AIR INJECTION CONTROL SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ..	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ..	Require repair or replacement of hardware.
Connector broken .....	A .	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A .	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	B .....	(2) Require repair or replacement. Further inspection required.
Leaking .....	A .	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B .	Require repair or replacement.
Restricted, affecting performance .....	A .	Require repair or replacement.
Terminal broken .....	A .	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 .	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A .	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 .	Suggest repair or replacement.
Terminal loose, affecting performance .....	B .	Require repair or replacement.
Terminal loose, not affecting performance ..	1 .	Suggest repair or replacement.
Threads damaged .....	A .	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B .	Require repair or replacement.
Wire lead corroded .....	A .	Require repair or replacement.
Wire lead open .....	A .	Require repair or replacement.
Wire lead shorted .....	A .	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## AIR PLENUMS

## AIR PLENUM INSPECTION

Condition	Code	Procedure
Integrated air or fuel control components inoperative .....	A .....	(1) Require repair or replacement.
Internal air or fuel components damaged, affecting performance ..	A ...	Require repair or replacement of component.
Internal air or fuel components damaged, not affecting performance ..	.. ..	No service suggested or required.
Internal air or fuel components missing .....	C .....	Require replacement of component.
Leaking .....	A ..	Require repair or replacement.
Restricted .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A ..	Require repair or replacement.
(1) - Inoperative includes intermittent operation or out of OEM specification.		

## AIR PUMP BELTS

### AIR PUMP BELT INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B .....	(1) Further inspection required.
Cracked .....	1 .....	Suggest replacement.
Frayed .....	1 .....	Suggest replacement.
Maintenance intervals ...	3 ...	Suggest replacement to comply with vehicle OEM recommended service intervals.
Missing .....	C .....	Require replacement.
Noisy .....	2 .....	(2) Further inspection required.
Plies separated .....	A .....	Require replacement.
Tension out of specification .....	B .....	Require adjustment or replacement.
Worn beyond adjustment range .....	B .....	Require replacement.
Worn so it contacts bottom of pulley .....	A .....	Require replacement.
(1) - Determine cause of incorrect alignment and require repair.		
(2) - Determine cause of noise and suggest repair.		

## AIR PUMPS (ELECTRIC-DRIVEN)

### AIR PUMP (ELECTRIC-DRIVEN) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	A .....	(2) Require replacement.
Leaking .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 .....	Suggest replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A ..	Require repair or replacement.
(1) - Determine cause and correct prior to repair or replacement of part.		
(2) - Inoperative includes intermittent operation or out of OEM specification.		

## AIR TUBES

See AIR DUCTS AND TUBES.

## ASPIRATOR, CHECK AND DECEL VALVES

### ASPIRATOR, CHECK AND DECEL VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement

Inoperative .....	A	.....	(1) Require repair or replacement.
Leaking .....	A	.....	Require replacement.
Melted, affecting performance .....	A	.....	Require replacement.
Melted, not affecting performance .....	..	.....	No service suggested or required.
Missing .....	C	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	..	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## BAFFLES

See SHROUDS, BAFFLES AND DEFLECTORS.

## BALLAST PRIMARY SUPPLY RESISTOR WIRES

See BALLAST RESISTORS AND PRIMARY SUPPLY RESISTOR WIRES.

## BALLAST RESISTORS AND PRIMARY SUPPLY RESISTOR WIRES

### BALLAST RESISTOR AND PRIMARY SUPPLY RESISTOR WIRE INSPECTION

Condition	Code		Procedure
Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Conductor exposed .....	A	.....	Require replacement.
Connector broken .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Inoperative .....	A	.....	(2) Require replacement.
Insulation overheated ...	A	.....	Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.



- (1) - Determine cause and correct prior to repair or replacement of part.  
 (2) - Inoperative includes intermittent operation or out of OEM specification.

## BAROMETRIC PRESSURE SENSORS

### BAROMETRIC PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ...	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or

- replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.
- 

## BATTERIES

Proper operation of any electrical system or component can be affected by battery condition. The battery(ies) must meet or exceed minimum specification for vehicle as equipped and test to that specific battery's CCA.

### Definition of Terms

- \* Battery Performance Testing  
Testing that determines whether or not a battery meets both vehicle OEM and battery manufacturer's specifications.
- \* Cold Cranking Amp (CCA) Rating  
The number of amperes a new, fully charged battery at 0° F (-17.8° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).
- \* Cranking Amps (CA)  
The number of amperes a new, fully charged battery, typically at 32° F (0° C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12-volt battery).
- \* OEM Cranking Amps  
The minimum CCA required by the original vehicle manufacturer for a specific vehicle.

### BATTERY INSPECTION

Condition	Code	Procedure
Battery frozen .....	..	(1) Further inspection required.
Case leaking .....	A	Require replacement.
Casing swollen .....	A	(2) Further inspection required.
Circuit open internally .	A	Require replacement.
Electrolyte contamination .....	A	(2) Further inspection required.
Electrolyte discoloration .....	A	(2) Further inspection required.
Fails to accept and hold charge .....	A	(3) Require replacement.
Fluid level low .....	B	(4) Further inspection required.
Out of performance specification for battery .....	B	(5) Require replacement.
Out of specification for application .....	B	(5) Require replacement.

Post (top or side) burned, affecting performance ..	A .....	(6) Require repair or replacement.
Post (top or side) burned, not affecting performance .....	2 .....	(6) Suggest repair or replacement.
Post (top or side) corroded, affecting performance .....	A .....	Require repair.
Post (top or side) corroded, not affecting performance .....	2 .....	Suggest repair.
Post (top or side) loose .....	A .....	Require replacement.
Post (top or side) melted, affecting performance .....	A .....	(6) Require repair or replacement.
Post (top or side) melted, not affecting performance .....	2 .....	(6) Suggest repair or replacement.
Specific gravity low ....	B .....	(7) Further inspection required.
State of charge low .....	A .....	(7) Further inspection required.
Top dirty .....	2 .....	Suggest cleaning battery.
Top wet .....	A ...	(8) Require cleaning battery. Further inspection required.
Vent cap loose .....	A ...	Require repair or replacement of vent cap.
Vent cap missing .....	C .....	Require replacement of vent cap.

- (1) - DO NOT attempt to charge a frozen battery. Allow battery to warm thoroughly and then performance-test. If battery fails performance test, require replacement.
- (2) - No service suggested or required unless the battery fails performance test, in which case, require replacement.
- (3) - This phrase refers to a battery that fails to either accept and/or retain a charge using appropriate times listed in the Battery Charging Guide of the BCI Service Manual, battery charger operating manual, or battery manufacturer's specifications.
- (4) - Determine cause of low fluid level. Refill to proper level(s) with water (distilled water preferred). Recharge battery and performance-test.
- (5) - The battery may meet battery manufacturer's specifications but test below the minimum specification defined by the vehicle's OEM for that vehicle.
- (6) - Determine cause and correct prior to repair or replacement of part.
- (7) - Recharge and test to manufacturer's specifications. If battery fails performance test, require replacement.
- (8) - Check fluid level and adjust to manufacturer's specification. Suggest checking charging system for proper operation.

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## BATTERY CABLES, WIRES AND CONNECTORS

## BATTERY CABLE, WIRE AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Insulation damaged, conductors exposed .....	A .....	(2) Require repair or replacement.
Insulation damaged, conductors not exposed ..	1 .....	Suggest replacement.
Open .....	A ..	Require repair or replacement.
Protective shield (conduit) melted .....	2 .....	(1) Suggest repair or replacement.
Protective shield (conduit) missing .....	2 ..	Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A ..	Require repair or replacement.
Routed incorrectly .....	B .....	Require repair.
Secured incorrectly .....	B .....	Require repair.
Shorted .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Voltage drop out of specification .....	A ..	Require repair or replacement.
(1) - Determine cause and correct prior to repair or replacement of part.		
(2) - Exposed conductor at replacement (aftermarket) terminal end does not require repair or replacement.		

## BATTERY CONNECTORS

See BATTERY CABLES, WIRES AND CONNECTORS.

## BATTERY TRAYS AND HOLD DOWN HARDWARE

## BATTERY TRAY AND HOLD DOWN HARDWARE INSPECTION

Condition	Code	Procedure
Battery improperly secured .....	2 .....	Suggest repair.
Bent, affecting performance .....	A ..	Require repair or replacement.
Bent, not affecting performance .....	.. .....	No service suggested or required.
Broken, affecting performance .....	A ..	Require repair or replacement.
Broken, not affecting performance .....	.. .....	No service suggested or required.
Corroded, affecting performance .....	A ..	Require repair or replacement.
Corroded, not affecting performance .....	2 ..	Suggest repair or replacement.
Cracked, affecting performance .....	A ..	Require repair or replacement.
Cracked, not affecting performance .....	1 ..	Suggest repair or replacement.
Missing .....	C .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Water drain clogged .....	A .....	Require repair.

## BATTERY WIRES

See BATTERY CABLES, WIRES AND CONNECTORS.

## BELT-DRIVEN AIR PUMPS

### BELT-DRIVEN AIR PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Inoperative .....	A .....	(1) Require replacement.
Leaking .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 .....	Suggest replacement.
Pulley alignment incorrect .....	B ..	Require repair or replacement.
Pulley bent .....	A .....	Require replacement.
Pulley cracked .....	A .....	Require replacement.
Pulley loose .....	A ..	Require repair or replacement.
Pulley missing .....	C .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads		

missing) ..... A .. Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of  
OEM specification.

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## BELT IDLER ASSEMBLIES (ACCESSORY AND CAM BELTS)

### BELT IDLER ASSEMBLY (ACCESSORY AND CAM BELT) INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bearings worn .....	1 .....	Suggest replacement.
Cracked .....	2 .....	Suggest replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 .....	Suggest replacement.
Seized .....	A ..	Require repair or replacement.

## BELT TENSIONERS (ACCESSORY AND CAM BELTS)

### BELT TENSIONER (ACCESSORY AND CAM BELT) INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B ..	Require repair or replacement.
Attaching hardware broken .....	A ..	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bearings worn .....	1 .....	Suggest replacement.
Belt tension incorrect ..	B ...	Require adjustment or repair.
Cracked .....	2 .....	Suggest replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 .....	Suggest replacement.
Pulley damaged, affecting belt life .....	A .....	Require replacement.
Seized .....	A ..	Require repair or replacement.

## BOOST CONTROL MECHANISMS

See WASTE GATES AND BOOST CONTROL MECHANISMS .

## CAMSHAFT POSITION SENSORS

### CAMSHAFT POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.
(1) - Determine cause and correct prior to repair or replacement of part.		
(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.		
(3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.		

## CARBURETORS AND CHOKES

NOTE: Proper operation of a carburetor includes the ability to control air/fuel mixtures during all phases of driving operation to comply with all federal and local emissions standards. Adjustments are to be considered repairs.

## CARBURETOR AND CHOKE INSPECTION

Condition	Code	Procedure
Air/fuel control		
incorrect .....	B ..	Require repair or replacement.
Application incorrect ...	B ..	Require repair or replacement.
Attaching hardware		
broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware		
missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Components binding .....	A ..	Require repair or replacement.
Components damaged, affecting operation or performance .....	A ..	Require repair or replacement.
Components missing .....	C .....	Require replacement of components.
Contaminated .....	A .....	(1) Require repair or replacement. Further inspection required.
Controlling linkages		
binding .....	A ...	Require repair or replacement of linkage.
Leaking .....	A ..	Require repair or replacement.
Mechanical operation		
incorrect .....	B ..	Require repair or replacement.
Operating incorrectly ...	B ..	Require repair or replacement.
(1) - Some components may be serviceable; check for accepted cleaning procedure. Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.		

## CASTING CORE PLUGS AND EXPANSION PLUGS

### CASTING CORE PLUG AND EXPANSION PLUG INSPECTION

Condition	Code	Procedure
Leaking .....	A .....	Require replacement.
Material type		
incorrect .....	2 .....	Suggest replacement.

## CHARGE AIR COOLERS "INTERCOOLERS" (CAC)

### CHARGE AIR COOLER "INTERCOOLER" (CAC) INSPECTION

Condition	Code	Procedure
Air-to-air intercooler		
leaking, affecting boost performance .....	A ..	Require repair or replacement.
Attaching hardware		
broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware		



missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Leaking coolant .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.

## CHECK VALVES

See ASPIRATOR, CHECK AND DECEL VALVES.

## CHOKES

See CARBURETORS AND CHOKES.

## CLUTCH PEDAL POSITION SWITCHES

### CLUTCH PEDAL POSITION SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	B	..... (2) Require repair or replacement. Further inspection required.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Wire lead conductors		

exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## COLD START INJECTORS

See FUEL AND COLD START INJECTORS.

## CONNECTORS

See WIRING HARNESSSES AND CONNECTORS.

## COOLANT

### COOLANT INSPECTION

Condition	Code	Procedure
Acidity (pH) incorrect ..	1 .....	Suggest correction or replacement.
Contaminated .....	B .....	(1) Require replacement or recycling. Further inspection required.
Level low .....	B ...	(2) Require filling to proper level.
Maintenance intervals ...	3 .....	(3) Suggest replacement.
Mixture incorrect .....	B .....	Require correction or replacement.
Type incorrect .....	B .....	Require replacement.

- (1) - Determine source of contamination and require correction prior to coolant replacement.
- (2) - Determine source of incorrect level and suggest repair.
- (3) - The system should be drained and/or flushed and refilled with correct coolant according to OEM recommended service interval and procedures.

## COOLANT RECOVERY TANKS

### COOLANT RECOVERY TANK INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ..	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Leaking .....	A .	Require repair or replacement.

Missing (if original  
equipment) ..... C ..... Require replacement.

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## COOLING FAN MOTOR MODULES

See COOLING FAN MOTOR RELAYS AND MODULES.

## COOLING FAN MOTOR RELAYS AND MODULES

### COOLING FAN MOTOR RELAY AND MODULE INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Housing cracked .....	2 ..	Suggest repair or replacement.
Malfunctioning .....	A .....	(2) Require repair or replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or  
replacement of part.

(2) - Includes inoperative, intermittent operation, failure  
to perform all functions, or out of OEM specification.

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## COOLING FAN MOTOR RESISTORS

### COOLING FAN MOTOR RESISTOR INSPECTION

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Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Missing .....	C .....	Require replacement.
Open .....	A .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Shorted .....	A .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ...	2 .	Suggest repair or replacement.
Terminal corroded, affecting performance ...	A .	Require repair or replacement.
Terminal corroded, not affecting performance ...	2 .	Suggest repair or replacement.
Terminal loose, affecting performance .....	B .	Require repair or replacement.
Terminal loose, not affecting performance ...	1 .	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

## COOLING FAN MOTOR SENSORS AND SWITCHES

### COOLING FAN MOTOR SENSOR AND SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or

Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## COOLING FAN MOTOR SWITCHES

See COOLING FAN MOTOR SENSORS AND SWITCHES.

## COOLING FAN MOTORS

### COOLING FAN MOTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ..	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Connector broken .....	A .	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A .	Require repair or replacement.

Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Hydraulic fan motor leaking .....	A	.	Require repair or replacement.
Inoperative .....	A	.....	(2) Require replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	.....	Suggest replacement.
Rotation incorrect for application .....	B	.	Require repair or replacement.
Terminal broken .....	A	.	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.	Require repair or replacement.
Terminal loose, not affecting performance ..	1	.	Suggest repair or replacement.
Vibration .....	1	.....	Suggest replacement.
Wire lead conductors exposed .....	B	.	Require repair or replacement.
Wire lead corroded .....	A	.	Require repair or replacement.
Wire lead open .....	A	.	Require repair or replacement.
Wire lead shorted .....	A	.	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

## CRANKSHAFT POSITION SENSORS

### CRANKSHAFT POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	.. Require repair or replacement.
Inoperative .....	B	.. Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.

Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## DECEL VALVES

See ASPIRATOR, CHECK AND DECEL VALVES.

## DEFLECTORS

See SHROUDS, BAFFLES AND DEFLECTORS.

## DIP STICKS AND TUBES

### DIP STICK AND TUBE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Bent .....	2	.. Suggest repair or replacement.
Broken, affecting performance (for example, fuel mixture) .....	A	.. Require repair or replacement.
Broken, not affecting performance .....	2	.. Suggest repair or replacement.
Leaking, affecting performance (for example, fuel mixture) .....	A	.. Require repair or replacement.
Leaking, not affecting performance .....	2	.. Suggest repair or replacement.
Missing	C	Require replacement.

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## DIP STICK TUBES

See DIP STICKS AND TUBES.

## DISTRIBUTOR ADVANCES AND RETARDERS (MECHANICAL AND VACUUM)

### DISTRIBUTOR ADVANCE AND RETARDER (MECHANICAL AND VACUUM) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Binding .....	A ..	Require repair or replacement.
Inoperative .....	A .....	(1) Require repair or replacement.
Leaking .....	A .....	Require replacement.
Out of specification ....	B ..	Require repair or replacement.

(1) - Inoperative includes intermittent operation.

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## DISTRIBUTOR BOOTS AND SHIELDS

### DISTRIBUTOR BOOT AND SHIELD INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Deteriorated .....	A .....	Require replacement.
Leaking .....	A .....	Require replacement.
Missing .....	A .....	Require replacement.
Torn .....	A .....	Require replacement.

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## DISTRIBUTOR CAPS

### DISTRIBUTOR CAP INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Arcing .....	A .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.



Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Burned .....	A	.....	Require replacement.
Carbon button missing ...	A	.....	Require replacement.
Carbon button worn, affecting performance ..	A	.....	Require replacement.
Carbon button worn, not affecting performance ..	1	.....	Suggest replacement.
Carbon-tracked .....	A	.....	Require replacement.
Cracked .....	A	.....	Require replacement.
Loose .....	2	..	Suggest repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal eroded, affecting performance .....	A	..	Require repair or replacement.
Terminal eroded, not affecting performance ..	..	.....	No service suggested or required.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

## DISTRIBUTOR RETARDERS (MECHANICAL AND VACUUM)

See

DISTRIBUTOR ADVANCES AND RETARDERS (MECHANICAL AND VACUUM) .

## DISTRIBUTOR ROTORS

### DISTRIBUTOR ROTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Carbon-tracked .....	A	..... Require replacement.
Contact burned .....	A	..... Require replacement.
Corroded .....	1	..... Suggest replacement.

Eroded .....	1	.....	Suggest replacement.
Loose .....	A	..	Require repair or replacement.
Out of specification ....	B	.....	Require replacement.

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## DISTRIBUTOR SHIELDS

See DISTRIBUTOR BOOTS AND SHIELDS.

## DISTRIBUTORS

### DISTRIBUTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bushings worn, affecting performance .....	A	.. Require repair or replacement.
Bushings worn, not affecting performance ..	1	.. Suggest repair or replacement.
Cam lobes worn, affecting performance .....	A	.. Require repair or replacement.
Cam lobes worn, not affecting performance ..	1	.. Suggest repair or replacement.
Gear broken .....	A	.. Require repair or replacement.
Gear worn, affecting performance .....	A	..... Require replacement.
Gear worn, not affecting performance .....	..	..... No service suggested or required.
Integrated pickup triggering device loose .....	A	.. Require repair or replacement.
Integrated pickup triggering device magnetism incorrect ....	A	.. Require repair or replacement.
Leaking oil internally ..	A	.. Require repair or replacement.
Noisy .....	2	.. Suggest repair or replacement.
Pickup triggering device (reluctor) broken .....	A	.. Require repair or replacement.
Pickup triggering device (reluctor) loose .....	A	.. Require repair or replacement.
Pickup triggering device (reluctor) weak .....	A	.. Require repair or replacement.
Reluctor (pickup triggering device) broken .....	A	.. Require repair or replacement.
Reluctor (pickup triggering device) loose .....	A	.. Require repair or replacement.
Reluctor (pickup triggering device) weak .....	A	.. Require repair or replacement.
Shaft bent .....	A	..... Require replacement.
Thrust washer broken ....	A	.. Require repair or replacement.

Thrust washer missing ...	C	..	Require repair or replacement.
Thrust washer worn, affecting performance ..	A	..	Require repair or replacement.
Thrust washer worn, not affecting performance ..	1	..	Suggest repair or replacement.

## EARLY FUEL EVAPORATION VALVES (HEAT RISER ASSEMBLIES)

### EARLY FUEL EVAPORATION VALVE (HEAT RISER ASSEMBLY) INSPECTION

Condition	Code	Procedure
Broken .....	A	.. Require replacement of affected parts.
Diaphragm inoperative ...	A	..... (1) Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Noisy .....	2	.. Suggest repair or replacement.
Seized .....	A	.. Require replacement of affected parts.
Spring broken .....	B	..... Require replacement of spring(s).
Spring inoperative .....	A	..... (2) Require replacement of spring(s).

(1) - Inoperative includes intermittent operation or out of OEM specification. If the inoperative diaphragm is separate from the heat riser, then require replacement of the inoperative diaphragm. If the inoperative diaphragm is part of the heat riser, then replace the heat riser.

(2) - Inoperative includes intermittent operation or out of OEM specification.

## EGR COOLERS

See EGR PLATES AND COOLERS.

## EGR EXHAUST MANIFOLD PASSAGES

See EGR INTAKE AND EXHAUST MANIFOLD PASSAGES.

## EGR INTAKE AND EXHAUST MANIFOLD PASSAGES

### EGR INTAKE AND EXHAUST MANIFOLD PASSAGE INSPECTION

Condition	Code	Procedure
Leaking .....	A	.. Require repair or replacement.
Restricted, affecting performance .....	A	.. Require repair or replacement.

## EGR PLATES AND COOLERS

### EGR PLATE AND COOLER INSPECTION

Condition	Code	Procedure
Leaking .....	A	.. Require repair or replacement.

Missing .....	C .....	Require replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.

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## ELECTRONIC SPARK CONTROL MODULES

### ELECTRONIC SPARK CONTROL MODULE INSPECTION

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Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	A .....	Require repair.
Contaminated .....	A .....	(2) Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Malfunctioning .....	A .....	(3) Require repair or replacement.
Missing .....	C .....	Require replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement of source.
- (3) - Includes inoperative, intermittent operation, failure to

perform all functions, or out of OEM specification.

## ELECTRONIC TRANSMISSION CONTROL DEVICES

### ELECTRONIC TRANSMISSION CONTROL DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Malfunctioning .....	A .....	(3) Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.

- (3) - Includes inoperative, intermittent operation, failure to perform all functions, or out of OEM specification.

## ELECTRONIC TRANSMISSION FEEDBACK DEVICES

### ELECTRONIC TRANSMISSION FEEDBACK DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ..	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
 (2) - Determine source of contamination, such as engine coolant,

fuel, metal particles, or water. Require repair or replacement.

- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## ENGINE COOLANT TEMPERATURE SENSORS

### ENGINE COOLANT TEMPERATURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## ENGINE COOLING SYSTEMS

NOTE: Overheating, poor engine performance, and insufficient cabin heat can be affected by, but are not limited to, all of the components in the engine cooling system.

## ENGINE COVERS (OIL PAN, VALVE COVER, TIMING COVER)

### ENGINE COVER (OIL PAN, VALVE COVER, TIMING COVER) INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	B .....	Require replacement.
Attaching hardware loose .....	A ..	Require repair or replacement.
Attaching hardware missing .....	C .....	Require replacement.
Baffle loose .....	2 ..	Suggest repair or replacement.
Baffle missing .....	C .....	Require replacement.
Bent, affecting performance .....	A ..	Require repair or replacement.
Bent, not affecting performance .....	.. .....	No service suggested or required.
Cracked (not leaking) ...	2 ..	Suggest repair or replacement.
Leaking externally .....	A ..	Require repair or replacement.
Leaking internally, causing fluid contamination .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Restricted passage .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.

## ENGINE OIL

### ENGINE OIL INSPECTION

Condition	Code	Procedure
Contaminated .....	A ..	(1) Require replacement of oil and filter.
Level high .....	B ...	Determine source of incorrect level and require repair.
Level low .....	B ...	Determine source of incorrect level and require repair.
Maintenance intervals ...	3 ...	Suggest replacement to comply with vehicle's OEM recommended service intervals.

- (1) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water when changing oil. Require



repair or replacement.

## ENGINE OIL CANISTERS

See ENGINE OIL FILTERS AND CANISTERS.

## ENGINE OIL COOLERS (EXTERNAL)

### ENGINE OIL COOLER (EXTERNAL) INSPECTION

Condition	Code	Procedure
Air flow restriction ....	A ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bypassed .....	A ..	Require repair or replacement.
Connection leaking .....	A ..	Require repair or replacement.
Corroded .....	1 ..	Suggest repair or replacement.
Fins damaged, affecting performance .....	A ..	Require repair or replacement.
Fins damaged, not affecting performance ..	2 ..	Suggest repair or replacement.
Fluid flow restrictions ..	A ..	Require repair or replacement.
Internal restrictions, affecting performance ..	A ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Missing .....	A .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## ENGINE OIL DRAIN PLUGS AND GASKETS

### ENGINE OIL DRAIN PLUG AND GASKET INSPECTION

Condition	Code	Procedure
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Threads damaged .....	A .....	(1) Require repair or replacement.

(1) - Some OEMs require replacement of drain plug gasket when removing drain plug. Inspect threads in oil pan for damage.

## ENGINE OIL FILTERS AND CANISTERS

### ENGINE OIL FILTER AND CANISTER INSPECTION

Condition	Code	Procedure
Bulged .....	A .....	(1) Require replacement.

Further inspection required.			
Canister attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Canister attaching hardware loose .....	A	.....	Require repair.
Canister attaching hardware missing .....	C	.....	Require replacement.
Canister attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Center tube collapsed ...	A	.....	(2) Require replacement. Further inspection required.
Contaminated .....	A	.....	(3) Require replacement of oil and filter.
Dented .....	2	.....	(4) Suggest replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Maintenance intervals ...	3	...	Suggest replacement to comply with vehicle's OEM recommended service intervals.

- (1) - Inspect pressure relief valve.
- (2) - Inspect bypass.
- (3) - Determine cause of contamination, such as engine coolant, fuel, metal particles, or water when changing oil. Require repair or replacement.
- (4) - Determine cause, such as broken motor mount.

## ENGINE OIL GASKETS

See ENGINE OIL DRAIN PLUGS AND GASKETS.

## ENGINE OIL PRESSURE GAUGES (MECHANICAL)

### ENGINE OIL PRESSURE GAUGE (MECHANICAL) INSPECTION

Condition	Code	Procedure
Indicates out of range ..	B	..... (1) Further inspection required.
Inoperative .....	A	..... (2) Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Reads inaccurately .....	2	.. Suggest repair or replacement.

- (1) - Gauge may indicate problem with contaminated oil, level, pressure, or temperature, or problem with gauge.
- (2) - Gauge may indicate problem with contaminated oil, level, pressure, or temperature, or problem with gauge. Inoperative includes intermittent operation, out of OEM specification, or out of range. Further inspection required to determine cause.

## EVAPORATIVE EMISSION (EVAP) CANISTER FILTERS

### EVAPORATIVE EMISSION (EVAP) CANISTER FILTER INSPECTION

Condition	Code	Procedure
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Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Maintenance interval ....	3	...	Suggest replacement to comply with OEM recommended service interval.
Missing .....	C	.....	Require replacement.
Restricted, affecting performance .....	A	.....	Require replacement.
Restricted, not affecting performance .....	1	.....	Suggest replacement.
Water-contaminated .....	A	.....	Require replacement.

## EVAPORATIVE EMISSION (EVAP) CANISTER PURGE DEVICES

### EVAPORATIVE EMISSION (EVAP) CANISTER PURGE DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Restricted, affecting performance .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.

Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## EVAPORATIVE EMISSION (EVAP) CANISTERS

### EVAPORATIVE EMISSION (EVAP) CANISTER INSPECTION

Condition	Code	Procedure
Inoperative .....	A .....	(1) Require repair or replacement.
Leaking .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Saturated .....	A .....	Require replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.

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## EVAPORATIVE EMISSION (EVAP) FEEDBACK DEVICES

### EVAPORATIVE EMISSION (EVAP) FEEDBACK DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.

Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## EXHAUST GAS RECIRCULATION DEVICES

### EXHAUST GAS RECIRCULATION DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.

Connector missing .....	C	.....	Require replacement.
Contaminated .....	A	.....	(2) Require repair or replacement.
Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Restricted, not affecting performance .....	1	..	Suggest repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## EXHAUST GAS RECIRCULATION FEEDBACK DEVICES

### EXHAUST GAS RECIRCULATION FEEDBACK DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.

Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Contaminated .....	A	.....	(2) Require repair or replacement.
Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Restricted, not affecting performance .....	1	..	Suggest repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## EXPANSION PLUGS

See CASTING CORE PLUGS AND EXPANSION PLUGS.

## FAN CONTROL SENSORS

### FAN CONTROL SENSOR INSPECTION

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Condition	Code	Procedure
Attaching hardware		

missing .....	C	.....	Require replacement of hardware.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	...	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Contaminated .....	A	.....	(2) Require repair or replacement.
Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## FUEL

### FUEL INSPECTION

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Condition	Code	Procedure
Contaminated .....	B .....	(1) Require repair or replacement.
Fuel incorrect .....	B .....	(2) Require flushing of system.
(1) - Determine of source of contamination. Require repair or replacement.		
(2) - If a fuel other than specification fuel is present in the system, the required service is to flush and fill with the correct fuel.		

## FUEL ACCUMULATORS AND DAMPERS

### FUEL ACCUMULATOR AND DAMPER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connections leaking .....	A ..	Require repair or replacement.
Inoperative .....	A .....	(1) Require replacement.
Leaking .....	A .....	Require replacement.
(1) - Inoperative includes intermittent operation or out of OEM specification.		

## FUEL AND COLD START INJECTORS

NOTE: You are not required to replace injectors in sets. However, you may suggest replacement of all injectors for preventive maintenance.

### FUEL AND COLD START INJECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.

Flow restricted .....	B	..	Require repair or replacement.
Inoperative .....	B	.....	(2) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Resistance out of specification .....	B	.....	Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation, out of OEM specification. Some components may be serviceable.

## FUEL DAMPERS

See FUEL ACCUMULATORS AND DAMPERS.

## FUEL DELIVERY CHECK VALVES

### FUEL DELIVERY CHECK VALVE INSPECTION

Condition	Code	Procedure
Inoperative .....	A	..... (1) Require replacement.
Leaking externally .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Pressure leaking (bleeds down) .....	A	.. Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## FUEL DISTRIBUTORS (BOSCH CIS)

### FUEL DISTRIBUTOR (BOSCH CIS) INSPECTION

Condition	Code	Procedure
Inoperative .....	A	..... (1) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Out of specification ....	B	.. Require repair or replacement.
Restricted, affecting		

performance .....	A .....	(2) Require repair or replacement. Further inspection required.
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- (1) - Inoperative includes intermittent operation.  
(2) - Some components may be serviceable; check for accepted cleaning procedure.

## FUEL FILLER NECKS AND RESTRICTORS

### FUEL FILLER NECK AND RESTRICTOR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Restricted .....	2 ..	Suggest repair or replacement.

## FUEL FILTERS

### FUEL FILTER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Leaking .....	A ..	Require repair or replacement.
Maintenance interval ....	3 ...	Suggest replacement to comply with OEM recommended service interval.
Missing .....	C .....	Require replacement.
Restricted, affecting performance .....	A .....	Require replacement.
Restricted, not affecting performance .....	1 .....	Suggest replacement.
Water-contaminated .....	2 .....	Suggest replacement.

## FUEL INJECTORS

### FUEL INJECTOR INSPECTION

Condition	Code	Procedure
Attaching hardware		

missing .....	C	.....	Require replacement of hardware.
Attaching hardware threads damaged .....	A	..	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	..	Require repair or replacement of hardware.
Connector broken .....	A	.	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Contaminated .....	A	.....	(2) Require repair or replacement.
Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	.	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	.	Require repair or replacement.
Restricted, affecting performance .....	A	.	Require repair or replacement.
Restricted, not affecting performance .....	2	.	Suggest repair or replacement.
Terminal broken .....	A	.	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.	Require repair or replacement.
Terminal loose, not affecting performance ..	1	.	Suggest repair or replacement.
Threads damaged .....	A	.	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	.	Require repair or replacement.
Wire lead corroded .....	A	.	Require repair or replacement.
Wire lead open .....	A	.	Require repair or replacement.
Wire lead shorted .....	A	.	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## FUEL LEVEL SENDERS

## FUEL LEVEL SENDER INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Inoperative .....	A .....	(1) Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

(2) - Determine cause and correct prior to repair or replacement of part.

## FUEL PRESSURE REGULATORS

### FUEL PRESSURE REGULATOR INSPECTION

Condition	Code	Procedure
Contaminated .....	2 .....	(1) Suggest repair or replacement. Further inspection required.
Inoperative .....	B .....	(2) Require repair or replacement.
Leaking (internally or externally) .....	A ..	Require repair or replacement.
Pressure out of specification .....	B ..	Require repair or replacement.
Vapor bypass restricted ..	A ..	Require repair or replacement.

(1) - Some components may be serviceable; check for accepted cleaning procedure. Determine source of contamination. Require repair or replacement.

(2) - Inoperative includes intermittent operation or out of OEM specification.

## FUEL PUMPS (IN-TANK AND EXTERNAL, ELECTRICAL OR MECHANICAL)

### FUEL PUMP (IN-TANK AND EXTERNAL, ELECTRICAL OR MECHANICAL) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require replacement.
Inoperative .....	A .....	(3) Require repair or replacement.
Leaking externally (includes pulsator) ....	A ..	Require repair or replacement.
Leaking internally (includes pulsator) ....	A ..	Require repair or replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Out of specification ....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Determine source of contamination. Require repair or replacement.

(3) - Inoperative includes intermittent operation.

## FUEL RAILS

### FUEL RAIL INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Contaminated .....	A .....	(1) Require replacement.
Leaking .....	A ..	Require repair or replacement.
Restricted .....	A ..	Require repair or replacement.
Rust-pitted .....	1 .....	Suggest replacement.

(1) - Determine source of contamination. Require repair or replacement.

## FUEL RESTRICTORS

See FUEL FILLER NECKS AND RESTRICTORS.

## FUEL TANKS

### FUEL TANK INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Baffles loose .....	A ..	Require repair or replacement.
Contaminated .....	A .....	(1) Require repair.
Corroded internally .....	A ..	Require repair or replacement.
Distorted, affecting performance .....	B .....	Require replacement.
Distorted, not affecting performance .....	.. .....	No service suggested or required.
Leaking .....	A ..	Require repair or replacement.

(1) - Determine source of contamination. Require repair or replacement.

## GAS CAPS

### GAS CAP INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Fails to maintain proper pressure .....	A .....	Require replacement.
Gaskets missing .....	C .....	Require replacement.
Leaking .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Plugged (vacuum and pressure relief) .....	A .....	Require replacement.
Seals missing .....	C .....	Require replacement.

## GASKETS

### GASKET INSPECTION

Condition	Code	Procedure
Leaking .....	A .....	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

## GROMMETS (VALVE COVER)

### GROMMET (VALVE COVER) INSPECTION

Condition	Code	Procedure
Leaking .....	2 .....	(1) Suggest repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

## HARMONIC DAMPERS

### HARMONIC DAMPER INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ..	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Cracked .....	A .....	Require replacement.
Dented (fluid type only) .....	A .....	Require replacement.
Keyway distorted .....	A .	Require repair or replacement.
Leaking (Fluid damper only) .....	A .....	Require replacement.
Loose .....	A .....	Require replacement.
Noisy .....	A .....	Require replacement.



Outer ring slipped out of position .....	A	.....	Require replacement.
Positioned incorrectly ..	A	.	Require repair or replacement.
Rubber damping material deteriorated .....	1	.....	Suggest replacement.
Seal surface worn, causing a leak .....	A	.	Require repair or replacement.
Threads damaged .....	A	.	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

## HEATER CONTROL VALVES

### HEATER CONTROL VALVE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bypassed .....	A	..... Require replacement.
Coolant leak .....	A	.. Require repair or replacement.
Malfunctioning .....	A	..... (1) Require repair or replacement.
Missing .....	C	..... Require replacement.
Restricted .....	A	.. Require repair or replacement.
Vacuum leak .....	A	.. Require repair or replacement.

(1) - Includes inoperative, intermittent operation, or failure to perform all functions.

## HEATER CORES

### HEATER CORE INSPECTION

Condition	Code	Procedure
Air flow restriction ....	A	.. Require repair or replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bypassed .....	A	.. Require repair or replacement.
Connection leaking .....	A	.. Require repair or replacement.
Corroded .....	1	.. Suggest repair or replacement.
Fins damaged, affecting performance .....	A	.. Require repair or replacement.
Fins damaged, not affecting performance ..	2	.. Suggest repair or replacement.
Internal restrictions,		

affecting performance ..	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.

## HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS

NOTE: When replacing fuel lines and hoses, replace with product that meets or exceeds OEM design specifications.

### HOSE AND TUBE COUPLER, CONNECTOR AND CLAMP INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Connected incorrectly ...	A	..... Require repair.
Corroded, not reusable ..	1	..... Suggest replacement.
Cracked .....	A	..... Require replacement.
Insufficient clamping force, allowing hose to leak .....	A	.. Require repair or replacement.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Safety clip missing (not leaking) .....	C	... Require replacement of safety clip.
Stripped .....	A	..... Require replacement.

## HOSE CLAMPS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

## HOSE CONNECTORS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

## HOSE COUPLERS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS.

## HOSES AND TUBES (FUEL LINES, RADIATOR, VACUUM, BY PASS, HEATER, RECOVERY TANK AND OIL COOLERS)

### HOSE AND TUBE (FUEL LINE, RADIATOR, VACUUM, BY PASS, HEATER, RECOVERY TANK AND OIL COOLER) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Connected incorrectly ...	A	..... Require repair.
Corroded, not reusable ..	1	..... Suggest replacement.
Cracked .....	A	..... Require replacement.
Dry-rotted .....	1	.. Suggest repair or replacement.
Hard .....	1	.. Suggest repair or replacement.
Inner fabric (webbing) damaged .....	A	..... Require replacement.
Insufficient clamping force, allowing hose to leak .....	A	.. Require repair or replacement.
Leaking .....	A	.. Require repair or replacement.
Maintenance intervals ...	3	..... Suggest replacement.

Melted .....	1	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Outer covering damaged ..	1	.....	Suggest replacement.
Outer covering damaged to the extent that the inner fabric is visible .....	A	.....	Require replacement.
Protective sleeves damaged .....	2	.	Suggest replacement of sleeves.
Protective sleeves missing .....	2	.	Suggest replacement of sleeves.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Restricted, not affecting performance .....	2	..	Suggest repair or replacement.
Routed incorrectly .....	2	..	Suggest repair or replacement.
Safety clip missing .....	C	.....	Require replacement.
Spongy .....	1	..	Suggest repair or replacement.
Stripped .....	A	.....	Require replacement.
Swollen .....	B	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Type incorrect .....	1	..	Suggest repair or replacement.

## HOUSINGS

See THERMOSTATS AND HOUSINGS.

## IDLE AIR CONTROLS

### IDLE AIR CONTROL INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Restricted, affecting performance .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.

Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## IDLE SPEED CONTROL ACTUATORS

### IDLE SPEED CONTROL ACTUATOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.

Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1)	Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## IGNITION BOOTS

See

IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY) .

## IGNITION COIL TOWERS

See

IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY) .

## IGNITION COILS

### IGNITION COIL INSPECTION

Condition	Code	Procedure
Arcing .....	A	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or

Connector missing .....	C	.....	Require replacement.
Corroded, affecting performance .....	A	.....	Require replacement.
Corroded, not affecting performance .....	2	.....	Suggest replacement.
Distorted .....	..	..... (2)	No service suggested or required.
Inoperative .....	A	..... (3)	Require replacement.
Oil leaking .....	A	.....	Require replacement.
Out of specification ....	B	.....	Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1)	Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Distortion may be the result of overheating; coil should be tested.  
(3) - Inoperative includes intermittent operation.

## IGNITION CONTROL MODULES (ICM)

### IGNITION CONTROL MODULE (ICM) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Code set (if applicable) .....	A	..... (1) Further inspection required.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (2) Require repair or replacement.

Connector missing .....	A	.....	Require repair.
Contaminated .....	A	.....	(3) Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Malfunctioning .....	A	.....	(4) Require repair or replacement.
Missing .....	C	.....	Require replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
- (2) - Determine cause and correct prior to repair or replacement of part.
- (3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (4) - Includes inoperative, intermittent operation, or failure to perform all functions.

## IGNITION SWITCHES

See SWITCHES.

## IGNITION TERMINALS

See

IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY) .

## IGNITION WIRES, BOOTS, COIL TOWERS AND TERMINALS (SECONDARY)

NOTE: You are not required to replace ignition wires in sets. However, you may suggest replacement of the entire secondary wire set for preventive maintenance.

### IGNITION WIRE, BOOT, COIL TOWER AND TERMINAL (SECONDARY) INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.

Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	...	Require repair or replacement of hardware.
Carbon-tracked .....	A	.....	Require replacement.
Corroded .....	1	..	Suggest repair or replacement.
Insulation leaking (shorted) .....	A	..	Require repair or replacement.
Metal heat shield bent ..	2	..	Suggest repair or replacement.
Missing .....	C	.....	Require replacement.
Oil-soaked (spongy) .....	1	.....	Suggest replacement.
Resistance incorrect ....	B	.....	Require replacement.
Routed incorrectly .....	2	.....	(1) Suggest repair.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.

(1) - If improper routing affects the performance of other systems, require repair. Proper routing, hardware, heatshields, etc., are intended to prevent premature failure of secondary ignition components.

(2) - Determine cause and correct prior to repair or replacement of part.

## IN-TANK FUEL STRAINERS

### IN-TANK FUEL STRAINER INSPECTION

Condition	Code	Procedure
Missing .....	C	..... Require replacement.
Restricted .....	A	.. Require repair or replacement.
Torn .....	A	..... Require replacement.

## INERTIA FUEL SHUT-OFF SWITCHES

### INERTIA FUEL SHUT-OFF SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement



				of hardware.
Connector broken .....	A	..	Require repair or replacement.	
Connector melted .....	A	.....	(1) Require repair or replacement.	
Connector missing .....	C	.....	Require replacement.	
Contaminated .....	A	.....	(2) Require replacement.	
Inoperative .....	A	.....	(3) Require repair or replacement.	
Missing .....	C	.....	Require replacement.	
Terminal broken .....	A	..	Require repair or replacement.	
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.	
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance .....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.	
Wire lead conductors exposed .....	B	..	Require repair or replacement.	
Wire lead corroded .....	A	..	Require repair or replacement.	
Wire lead open .....	A	..	Require repair or replacement.	
Wire lead shorted .....	A	..	Require repair or replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification.

## INTAKE AIR TEMPERATURE SENSORS

### INTAKE AIR TEMPERATURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement.

				replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.	
Missing .....	C	.....	Require replacement.	
Resistance out of specification .....	B	..	Require repair or replacement.	
Restricted, affecting performance .....	A	..	Require repair or replacement.	
Terminal broken .....	A	..	Require repair or replacement.	
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.	
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance .....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.	
Threads damaged .....	A	..	Require repair or replacement.	
Threads stripped (threads missing) .....	A	.....	Require replacement.	
Wire lead conductors exposed .....	B	..	Require repair or replacement.	
Wire lead corroded .....	A	..	Require repair or replacement.	
Wire lead open .....	A	..	Require repair or replacement.	
Wire lead shorted .....	A	..	Require repair or replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## INTAKE MANIFOLDS

### INTAKE MANIFOLD INSPECTION

Condition	Code	Procedure
Corroded, affecting sealability .....	A	.. Require repair or replacement.
Integrated air or fuel control components inoperative .....	A	..... (1) Require repair or replacement.
Internal air or fuel components damaged, affecting performance ..	A	... Require repair or replacement of component.
Internal air or fuel components damaged, not affecting performance ..	..	..... No service suggested or required.
Internal air or fuel components missing .....	C	..... Require replacement of

Leaking .....	A	..	Require repair or replacement.
Out of specification ....	B	.....	Require replacement.
Restricted .....	A	..	Require repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	..	Require repair or replacement.
Warped .....	B	..	Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## INTERCOOLERS

See CHARGE AIR COOLERS "INTERCOOLERS" (CAC) .

## KNOCK SENSORS

### KNOCK SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	B	..... (2) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.

Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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### LIQUID VAPOR SEPARATORS

#### LIQUID VAPOR SEPARATOR INSPECTION

Condition	Code	Procedure
Inoperative .....	A .....	(1) Require repair or replacement.
Leaking .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Restricted .....	A ..	Require repair or replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.

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### MANIFOLD ABSOLUTE PRESSURE (MAP) SENSORS

#### MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.

Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## MASS AIR FLOW (MAF) SENSORS

### MASS AIR FLOW (MAF) SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.

Restricted, affecting performance .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## METAL AIR MANIFOLDS AND PIPES

### METAL AIR MANIFOLD AND PIPE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Broken .....	A	..... Require repair of injection tube or replacement of manifold.
Corroded, affecting structural integrity ...	1	..... Suggest replacement of injection tube or manifold.
Leaking .....	A	..... Require repair of injection tube or replacement of manifold.
Loose .....	A	..... Require repair.
Missing .....	C	..... Require replacement.
Restricted .....	A	..... Require replacement of injection tube or manifold.

Threads damaged .....	A	.....	Require repair.
Threads stripped (threads missing) .....	A	.....	Require replacement.

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## METAL AIR PIPES

See METAL AIR MANIFOLDS AND PIPES.

## MIX CONTROL SOLENOIDS

### MIX CONTROL SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Restricted, affecting performance .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Wire lead conductors exposed .....	B	.. Require repair or replacement.
Wire lead corroded .....	A	.. Require repair or replacement.
Wire lead open .....	A	.. Require repair or replacement.

Wire lead shorted ..... A .. Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## MOTOR MOUNTS

### MOTOR MOUNT INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Broken .....	A .....	Require replacement.
Leaking (hydraulic mount) .....	A .....	Require replacement.
Mounting hole worn, affecting performance ..	A .....	Require replacement.
Mounting hole worn, not affecting performance ..	.. ..	No service suggested or required.
Rubber deteriorated, affecting performance ..	A .....	Require replacement.
Rubber deteriorated, not affecting performance ..	.. ..	No service suggested or required.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

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## O-RINGS, GASKETS, SEALS AND SPRING LOCKS

### O-RING, GASKET, SEAL AND SPRING LOCK INSPECTION

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Condition	Code	Procedure
Leaking .....	A .....	(1) Require repair or replacement.
(1) - Require inspection of mating and sealing surface and repair or replace as necessary.		

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## O2 SENSORS

### O2 SENSOR INSPECTION

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Condition	Code	Procedure
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Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	..	Require repair or replacement of hardware.
Connector broken .....	A	..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	..	Require repair or replacement.
Connector melted .....	A	.....	(1) Require repair or replacement.
Connector missing .....	C	.....	Require replacement.
Contaminated .....	A	.....	(2) Require repair or replacement.
Inoperative .....	B	.....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Resistance out of specification .....	B	..	Require repair or replacement.
Restricted, affecting performance .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## OIL PRESSURE SENDING UNITS

## OIL PRESSURE SENDING UNIT INSPECTION

Condition	Code	Procedure
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	A .....	(2) Require repair or replacement.
Leaking .....	A .....	Require replacement.
Output signal incorrect ..	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Inoperative includes intermittent operation or out of OEM specification.

## OIL PUMP PICK-UP SCREENS

### OIL PUMP PICK-UP SCREEN INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Bypass stuck .....	A ..	Require repair or replacement.
Cracked .....	A ..	Require repair or replacement.
Loose .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Positioned incorrectly ..	A ..	Require repair or replacement.
Restricted .....	A ..	Require repair or replacement.
Screen torn .....	A .....	Require replacement.

## OIL PUMPS

## OIL PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Broken .....	A ..	Require repair or replacement.
Housing cracked .....	A ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Pressure relief valve stuck .....	A ..	Require repair or replacement.
Seized .....	A ..	Require repair or replacement.
Worn beyond specifications .....	B ..	Require repair or replacement.

## PARK NEUTRAL POSITION SWITCHES

### PARK NEUTRAL POSITION SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.

Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## PCV BREATHER ELEMENTS

### PCV BREATHER ELEMENT INSPECTION

Condition	Code	Procedure
Attaching hardware broken.....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Leaking .....	A	..... Require replacement.
Maintenance intervals ...	3	... Suggest replacement to comply with vehicle's OEM recommended service intervals.
Melted .....	A	..... Required replacement.
Missing .....	C	..... Require replacement.
Restricted, affecting performance .....	A	..... Require replacement.
Restricted, not affecting performance .....	1	..... Suggest replacement.
Water-contaminated .....	A	..... Require replacement.

## PCV ORIFICES

### PCV ORIFICE INSPECTION

Condition	Code	Procedure
Leaking .....	A	..... Require replacement.
Maintenance interval ....	3	... Suggest repair or replacement to comply with OEM recommended service intervals.

Missing .....	C .....	Require replacement.
Restricted .....	A ..	Require repair or replacement.

## PCV VALVES

### PCV VALVE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Grommet broken .....	A ...	Require repair or replacement of grommet.
Grommet missing .....	C .	Require replacement of grommet.
Grommet not functioning .....	A ...	Require repair or replacement of grommet.
Inoperative .....	A .....	(1) Require replacement.
Leaking .....	A .....	Require replacement.
Maintenance interval ....	3 ...	Suggest replacement to comply with vehicle's OEM recommended service intervals.
Missing .....	C .....	Require replacement.
Restricted .....	A .....	Require replacement.

(1) - Inoperative includes intermittent operation or out of  
OEM specification.

## PICK-UP ASSEMBLIES (INCLUDES MAGNETIC, HALL EFFECT AND OPTICAL)

### PICK-UP ASSEMBLY (MAGNETIC, HALL EFFECT AND OPTICAL) INSPECTION

Condition	Code	Procedure
Adjustment incorrect ....	B .....	Require repair.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Inoperative .....	B .....	(2) Require replacement.
Oil-soaked .....	A .....	Require replacement.

Terminal broken .....	A	..	Require repair or replacement.
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Inoperative includes intermittent operation or out of OEM specification. Refer to OEM recommended service' procedures.

## POWER STEERING PRESSURE SENSORS

### POWER STEERING PRESSURE SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Restricted, affecting performance .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or

					replacement.
Terminal burned, not affecting performance	..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance	..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance	..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance	.....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance	..	1	..	Suggest repair or replacement.	
Threads damaged	.....	A	..	Require repair or replacement.	
Threads stripped (threads missing)	.....	A	.....	Require replacement.	
Wire lead conductors exposed	.....	B	..	Require repair or replacement.	
Wire lead corroded	.....	A	..	Require repair or replacement.	
Wire lead open	.....	A	..	Require repair or replacement.	
Wire lead shorted	.....	A	..	Require repair or replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## POWERTRAIN CONTROL MODULES (PCM) AND PROM

### POWERTRAIN CONTROL MODULE (PCM) AND PROM INSPECTION

Condition	Code	Procedure
Application incorrect	... B	..... Require replacement.
Attaching hardware missing	..... C	..... Require replacement of hardware.
Attaching hardware threads damaged	..... A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing)	..... A	... Require repair or replacement of hardware.
Code set (if applicable)	..... A	..... (1) Further inspection required.
Connector broken	..... A	.. Require repair or replacement.
Connector (Weatherpack type) leaking	..... A	.. Require repair or replacement.
Connector melted	..... A	..... (2) Require repair or replacement.
Connector missing	..... A	..... Require repair.
Contaminated	..... A	..... (3) Require repair or replacement.
Leaking	..... A	.. Require repair or replacement.
Malfunctioning	..... A	..... (4) Require repair or replacement.
Missing	..... C	..... Require replacement.
Terminal broken	..... A	.. Require repair or replacement.

Terminal burned, affecting performance .....	A	.....	(2) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Refer to manufacturer's diagnostic trouble code procedure and require repair or replacement of affected component(s).
- (2) - Determine cause and correct prior to repair or replacement of part.
- (3) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (4) - Includes inoperative, intermittent operation, failure to perform all functions, or out of OEM specification.

## POWERTRAIN CONTROL PROM

See POWERTRAIN CONTROL MODULES (PCM) AND PROM.

## PRESSURIZED EXPANSION TANK CAPS

See RADIATOR CAPS AND PRESSURIZED EXPANSION TANK CAPS.

## RADIATOR CAPS AND PRESSURIZED EXPANSION TANK CAPS

### RADIATOR CAP AND PRESSURIZED EXPANSION TANK CAP INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Coolant recovery check valve inoperative .....	A	..... (1) Require replacement.
Fails to maintain proper pressure .....	B	..... Require replacement.
Gasket missing .....	C	.. Require replacement of gasket.
Missing .....	C	..... Require replacement.
Seal missing .....	C	... Require replacement of seal.

- (1) - Inoperative includes intermittent operation or out of OEM specification.

## RADIATOR FAN BLADES



## RADIATOR FAN BLADE INSPECTION

Condition	Code	Procedure
Application incorrect ...	B	..... Require replacement.
Attaching hardware broken .....	A	.. Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	.. Require repair or replacement of hardware.
Bent .....	A	..... Require replacement.
Broken .....	A	..... Require replacement.
Cracked .....	A	..... Require replacement.
Loose .....	A	. Require repair or replacement.
Missing .....	C	..... Require replacement.

## RADIATOR FAN CLUTCHES

NOTE: Some lateral movement, measured at the fan blade tip, may be normal.

## RADIATOR FAN CLUTCH INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bearing noisy .....	A	..... Require replacement.
Bearing worn .....	A	..... Require replacement.
Fastener loose .....	A	... Require repair or replacement of fastener.
Inoperative .....	A	..... (1) Require replacement.
Leaking .....	1	..... Suggest replacement.
Seized .....	A	..... Require replacement.
Slips (insufficient fan speed) .....	A	..... Require replacement.
Thermal control incorrect .....	B	.. Require repair or replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## RADIATORS

## RADIATOR INSPECTION

Condition	Code	Procedure
Air flow restriction ....	A	..... Require repair.

Application incorrect ...	B	.....	Require replacement.
Attaching hardware broken .....	A	...	Require repair or replacement of hardware.
Attaching hardware missing .....	C	.....	Require replacement of hardware.
Attaching hardware not functioning .....	A	..	Require repair or replacement of hardware.
Connection leaking .....	A	..	Require repair or replacement.
Corroded .....	1	..	Suggest repair or replacement.
Fins damaged, affecting performance .....	A	..	Require repair or replacement.
Fins damaged, not affecting performance ..	2	..	Suggest repair or replacement.
Internal oil cooler leaking .....	A	..	Require repair or replacement.
Internal restrictions, affecting performance ..	B	..	Require repair or replacement.
Internal restrictions, not affecting performance ..	2	..	Suggest repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	..	Require repair or replacement.
Tubes damaged, affecting performance .....	A	..	Require repair or replacement.
Tubes damaged, not affecting performance ..	..	.....	No service suggested or required.

## ROLL OVER VALVES

### ROLL OVER VALVE INSPECTION

Condition	Code	Procedure
Inoperative .....	A	..... (1) Require replacement.
Leaking .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.

(1) - Inoperative includes intermittent operation or out of OEM specification.

## SEALING COMPOUNDS

### SEALING COMPOUND INSPECTION

Condition	Code	Procedure
Leaking .....	A	..... (1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

## SEALS

### SEAL INSPECTION

Condition	Code	Procedure
Leaking .....	A .....	(1) Require repair or replacement.
(1) - Require inspection of mating and sealing surface and repair or replace as necessary.		

## SECONDARY AIR INJECTION SYSTEM MANAGEMENT DEVICES

### SECONDARY AIR INJECTION SYSTEM MANAGEMENT DEVICE INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ..	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.

Wire lead open ..... A .. Require repair or replacement.  
Wire lead shorted ..... A .. Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## SENSORS AND ACTUATORS

NOTE: Conditions pertaining to the sensors and actuators listed in this section may be found under the name of the sensor or actuator.

### SENSOR ABBREVIATION TABLE

Sensor	Abbreviation
Accelerator Pedal Position Sensor .....	APP
Air Conditioning Cycling Switch .....	AC
Air Conditioning Pressure Sensor .....	..
Air Fuel Ratio Sensor .....	..
Barometric Pressure Sensor .....	BARO
Camshaft Position Sensor .....	CMP
Clutch Pedal Position Switch .....	CPP
Cooling Fan Motor Sensors and Switches .....	..
Crankshaft Position Sensor .....	CKP
Electronic Transmission Feedback Devices .....	..
Engine Coolant Temperature Sensor .....	ECT
Evaporative Emission feedback devices .....	..
Exhaust Gas Recirculation feedback devices .....	..
Fan Control Sensor .....	FC
Intake Air Temperature Sensor .....	IAT
Knock Sensor .....	KS
Manifold Absolute Pressure Sensor .....	MAP
Mass Air Flow Sensor .....	MAF
O2 Sensor .....	O2S
Park Neutral Position Switch .....	PNP
Power Steering Pressure Sensor .....	PSP
Thermal Vacuum Valve .....	TVV
Throttle Position Sensor .....	TP Sensor
Throttle Position Switch .....	..
Transmission Range Switch .....	TR Switch
Vehicle Speed Sensor .....	VSS
Volume Air Flow Sensor .....	VAF

### ACTUATOR ABBREVIATION TABLE

Actuator	Abbreviation
Air Injection Control Solenoid .....	..
Electronic Transmission control devices .....	..
Evaporative Emission Canister .....	EVAP
Purge Device .....	..
Exhaust Gas Recirculation Device .....	EGR
Fuel Injector .....	..
Idle Air Control .....	IAC

Idle Speed Control Actuator .....	ISC
Mix Control Solenoid .....	MC Solenoid
Secondary Air Injection System Management Device ....	AIR, PAIR
Vacuum Regulator Solenoid .....	..
Waste Gate Control Solenoid .....	..

## SHROUDS, BAFFLES AND DEFLECTORS

### SHROUD, BAFFLE AND DEFLECTOR INSPECTION

Condition	Code	Procedure
Application incorrect, affecting cooling system performance .....	A .	Require repair or replacement.
Attaching hardware broken .....	A ..	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Bent, affecting cooling system performance .....	A .	Require repair or replacement.
Blocked, affecting cooling system performance .....	A .	Require repair or replacement.
Broken, affecting cooling system performance .....	A .	Require repair or replacement.
Cracked, affecting cooling system performance .....	A .	Require repair or replacement.
Loose, affecting cooling system performance .....	A .....	Require repair.
Loose, not affecting cooling system performance .....	2 .....	Suggest repair.
Missing, affecting cooling system performance .....	C .....	Require replacement.

## SPARK PLUGS

NOTE: You are not required to replace spark plugs in sets.  
However, you may suggest replacement of the other plugs  
for preventive maintenance.

### SPARK PLUG INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Electrode eroded .....	1 .....	Suggest replacement.
Fouled .....	A .....	(1) Require repair or replacement.
Gap incorrect .....	B ..	Require repair or replacement.
Insulation broken .....	A .....	Require replacement
Insulator cracked .....	A .....	Require replacement.
Leaking compression .....	A ..	Require repair or replacement.
Maintenance interval ....	3 .....	Suggest replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads		

missing) ..... A ..... Require replacement.

(1) - Determine cause of fouling and suggest repair.

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## SPRING LOCKS

### SPRING LOCK INSPECTION

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Condition	Code	Procedure
Leaking .....	A .....	(1) Require repair or replacement.

(1) - Require inspection of mating and sealing surface and repair or replace as necessary.

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## SUPER CHARGERS

### SUPER CHARGER INSPECTION

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Condition	Code	Procedure
Attaching hardware damaged, affecting operation or performance .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Bearing noisy .....	A .....	Require replacement.
Bearing worn .....	A .....	Require replacement.
Boost pressure incorrect .....	A .....	(1) Require repair or replacement.
Clearance out of specification .....	B ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A ..	Require repair or replacement.

(1) - Boost pressure problems may be caused by other systems or components.

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## SWITCHES

### SWITCH INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement

				of hardware.
Binding, affecting performance .....	A	..	Require repair or replacement.	
Binding, not affecting performance .....	2	..	Suggest repair or replacement.	
Broken .....	A	..	Require repair or replacement.	
Burned, affecting performance .....	A	.....	(1) Require repair or replacement.	
Burned, not affecting performance .....	2	.....	(1) Suggest repair or replacement.	
Cracked, affecting performance .....	A	..	Require repair or replacement.	
Cracked, not affecting performance .....	1	..	Suggest repair or replacement.	
Leaking .....	A	..	Require repair or replacement.	
Malfunctioning .....	A	.....	(2) Require repair or replacement.	
Melted, affecting performance .....	A	.....	(1) Require repair or replacement.	
Melted, not affecting performance .....	2	.....	(1) Suggest repair or replacement.	
Missing .....	C	.....	Require replacement.	
Out of adjustment .....	B	..	Require repair or replacement.	
Terminal broken .....	A	..	Require repair or replacement.	
Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.	
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.	
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.	
Terminal loose, affecting performance .....	B	..	Require repair or replacement.	
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.	
Won't return .....	A	..	Require repair or replacement.	
Worn .....	1	.....	Suggest replacement.	

(1) - Determine cause and correct prior to repair or replacement of part.

(2) - Includes inoperative, intermittent operation, or failure to perform all functions.

## THERMAL VACUUM VALVES

### THERMAL VACUUM VALVE INSPECTION

Condition	Code	Procedure
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or

Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## THERMOSTATIC AIR DOOR ASSEMBLIES

### THERMOSTATIC AIR DOOR ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware damaged, affecting operation or performance .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Binding .....	A ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Seized .....	A ..	Require repair or replacement.



## THERMOSTATS AND HOUSINGS

### THERMOSTAT AND HOUSING INSPECTION

Condition	Code	Procedure
Application incorrect ...	B .....	Require replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware corroded .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Housing corroded .....	1 ..	Suggest replacement of housing.
Inoperative .....	A .....	(1) Require replacement.
Installation incorrect ..	B ..	Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Thermostat missing .....	C .....	Require replacement of thermostat.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A ..	Require repair or replacement.
(1) - Inoperative includes intermittent operation or out of OEM specification.		

## THROTTLE BODIES

### THROTTLE BODY INSPECTION

Condition	Code	Procedure
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Restricted .....	A .....	(3) Require repair.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	..	Require repair or replacement.
Throttle shaft binding, affecting performance ..	A	..	Require repair or replacement.
Throttle shaft worn, affecting performance ..	A	..	Require repair or replacement.
Throttle shaft worn, not affecting performance ..	1	..	Suggest repair or replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Some components may be serviceable; check for accepted cleaning procedure.

## THROTTLE CABLES

See THROTTLE LINKAGES AND CABLES.

## THROTTLE LINKAGES AND CABLES

### THROTTLE LINKAGE AND CABLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ..	Require repair or replacement of hardware.
Bent .....	A ..	Require repair or replacement.
Binding .....	A ..	Require repair or replacement.
Bracket bent, affecting performance .....	A ..	Require repair or replacement.
Bracket bent, not affecting performance ..	.. ..	No service suggested or required.
Bracket broken, affecting performance .....	A	Require replacement.
Bracket broken, not affecting performance ..	.. ..	No service suggested or required.
Bracket corroded, affecting performance ..	A ..	Require repair or replacement.
Bracket corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Bracket cracked, affecting performance .....	A ..	Require repair or replacement.
Bracket cracked, not affecting performance ..	1 ..	Suggest repair or replacement.

Bracket loose, affecting performance .....	A	..	Require repair or replacement.
Bracket loose, not affecting performance ..	1	..	Suggest repair or replacement.
Bracket missing .....	C	.....	Require replacement.
Broken .....	A	.....	Require replacement.
Cracked .....	A	..	Require repair or replacement.
Disconnected .....	A	..	Require repair or replacement.
Kinked .....	A	..	Require repair or replacement.
Melted .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	..	Suggest repair or replacement.
Out of adjustment .....	B	.....	(1) Require repair or replacement.
Routed incorrectly .....	2	.....	Suggest repair.
Seized .....	A	..	Require repair or replacement.

(1) - Follow OEM recommended adjustment procedures. Require repair or replacement if out of specification.

## THROTTLE POSITION SENSORS

### THROTTLE POSITION SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	.. (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not		

affecting performance ..	1	..	Suggest repair or replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## THROTTLE POSITION SWITCHES

### THROTTLE POSITION SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	.. Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	B	..... (2) Require repair or replacement. Further inspection required.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.

Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## TIMING BELT SPROCKETS

### TIMING BELT SPROCKET INSPECTION

Condition	Code	Procedure
Alignment incorrect .....	B	..... Require repair.
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Bent .....	A	..... Require replacement.
Cracked .....	A	..... Require replacement.
Key damaged .....	A	..... Require replacement.
Loose .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Pulley damaged, affecting belt life .....	A	..... Require replacement.
Sprocket damaged, affecting belt life ....	A	.. Require repair or replacement.
Sprocket loose .....	B	.. Require repair or replacement.
Sprocket-to-shaft alignment incorrect .....	B	.. Require repair or replacement.

## TIMING BELTS

### TIMING BELT INSPECTION

Condition	Code	Procedure
Adjustment incorrect ....	2	..... (1) Suggest adjustment.
Alignment incorrect .....	B	..... (2) Further inspection required.
Broken .....	A	..... Require replacement.
Cam timing out of specification .....	B	..... Require repair.
Cracked .....	1	..... Suggest replacement.
Fluid-soaked .....	1	... Suggest replacement. Further inspection required.
Frayed .....	1	..... Suggest replacement.
Maintenance intervals ...	3	... Suggest replacement to comply with vehicle OEM recommended

			service intervals.
Missing .....	C .....	(3) Require replacement.	
Noisy .....	2 .....	(4) Further inspection required.	
		See note below.	
Plies separated .....	A .....	Require replacement.	
Tension out of specification .....	B .....	Require adjustment or replacement.	
Teeth missing .....	A .....	Require replacement.	
(1) - Inspect belt tensioners, pulleys, and cover.			
(2) - Determine cause of incorrect alignment and require repair.			
(3) - CAUTION: Internal engine damage may result from timing belt damage/failure.			
(4) - Determine cause of noise and suggest repair.			

## TORQUE STRUTS

### TORQUE STRUT INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Binding .....	A .....	Require replacement.
Body dented .....	A .....	(1) Further inspection required.
Body punctured .....	A .....	Require replacement.
Bushing deteriorated, affecting performance ..	A .....	Require replacement.
Bushing deteriorated, not affecting performance ..	.. .....	No service suggested or required.
Bushings missing .....	C .....	Require replacement.
Bushings separated from mounting eye .....	1 .....	Suggest replacement.
Damping (none) .....	A .....	Require replacement.
Leaking oil, enough for fluid to be running down the body .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Noisy .....	2 .....	(2) Further inspection required.
Piston rod bent .....	A .....	Require replacement.
Piston rod broken .....	A .....	Require replacement.
Seized .....	A .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

- (1) - Require replacement of units where dents restrict strut piston rod movement. If dents don't restrict movement, no service is suggested or required.
- (2) - If noise is isolated to shock or strut, suggest replacement.

## TRANSMISSION RANGE SWITCHES

### TRANSMISSION RANGE SWITCH INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.
Wire lead open .....	A ..	Require repair or replacement.
Wire lead shorted .....	A ..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable;

check for accepted cleaning procedure.

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## TUBE CLAMPS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS .

## TUBE CONNECTORS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS .

## TUBE COUPLERS

See HOSE AND TUBE COUPLERS, CONNECTORS AND CLAMPS .

## TUBES

See HOSES AND TUBES (FUEL LINES, RADIATOR, BY PASS, HEATER, RECOVERY TANK AND OIL COOLERS) .

## TURBO CHARGERS

### TURBO CHARGER INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Boost pressure incorrect .....	A .....	(1) Require repair or replacement.
Leaking .....	A ..	Require repair or replacement.
Noisy .....	2 ..	Suggest repair or replacement.
Oil seal (internal) leaking .....	A ..	Require repair or replacement.
Vibrates .....	A ..	Require repair or replacement.

(1) - Boost pressure problems may be caused by other systems  
or components.

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## VACUUM CONNECTIONS

See VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC) .

## VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC)

### VACUUM HOSE, TUBE AND CONNECTION (NON-METALLIC) INSPECTION

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Condition	Code	Procedure
Leaking .....	A ..	Require repair or replacement.
Melted .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Oil-soaked (spongy) .....	1 .....	Suggest replacement.



Restricted .....	A	..	Require repair or replacement.
Surface cracks (dry-rotted) .....	1	.....	Suggest replacement.

## VACUUM REGULATOR SOLENOIDS

### VACUUM REGULATOR SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware threads damaged .....	A	... Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Contaminated .....	A	..... (2) Require repair or replacement.
Inoperative .....	B	..... (3) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Resistance out of specification .....	B	.. Require repair or replacement.
Restricted, affecting performance .....	A	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.
Terminal burned, affecting performance .....	A	..... (1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	.. Require repair or replacement.
Terminal corroded, not affecting performance ..	2	.. Suggest repair or replacement.
Terminal loose, affecting performance .....	B	.. Require repair or replacement.
Terminal loose, not affecting performance ..	1	.. Suggest repair or replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	..... Require replacement.
Wire lead conductors exposed .....	B	.. Require repair or replacement.
Wire lead corroded .....	A	.. Require repair or replacement.
Wire lead open .....	A	.. Require repair or replacement.
Wire lead shorted .....	A	.. Require repair or replacement.

(1) - Determine cause and correct prior to repair or replacement of part.

- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## VACUUM TUBES

See VACUUM HOSES, TUBES AND CONNECTIONS (NON-METALLIC) .

## VEHICLE SPEED SENSORS

### VEHICLE SPEED SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.
Wire lead conductors exposed .....	B ..	Require repair or replacement.
Wire lead corroded .....	A ..	Require repair or replacement.

Wire lead open ..... A .. Require repair or replacement.  
 Wire lead shorted ..... A .. Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

## VOLUME AIR FLOW SENSORS

### VOLUME AIR FLOW SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

Wire lead conductors				
exposed .....	B	..	Require repair or replacement.	
Wire lead corroded .....	A	..	Require repair or replacement.	
Wire lead open .....	A	..	Require repair or replacement.	
Wire lead shorted .....	A	..	Require repair or replacement.	

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

### WASTE GATE CONTROL SOLENOIDS

#### WASTE GATE CONTROL SOLENOID INSPECTION

Condition	Code	Procedure
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of hardware.
Attaching hardware threads stripped (threads missing) .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Contaminated .....	A .....	(2) Require repair or replacement.
Inoperative .....	B .....	(3) Require repair or replacement. Further inspection required.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Resistance out of specification .....	B ..	Require repair or replacement.
Restricted, affecting performance .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.

Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.
- (2) - Determine source of contamination, such as engine coolant, fuel, metal particles, or water. Require repair or replacement.
- (3) - Inoperative includes intermittent operation or out of OEM specification. Some components may be serviceable; check for accepted cleaning procedure.

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## WASTE GATES AND BOOST CONTROL MECHANISMS

### WASTE GATE AND BOOST CONTROL MECHANISM INSPECTION

Condition	Code	Procedure
Boost pressure incorrect .....	A	..... (1) Require repair or replacement. Further inspection required.
Leaking .....	A	.. Require repair or replacement.

(1) - Incorrect boost pressure includes intermittent operation or out of OEM specification.

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## WATER PUMPS (ELECTRIC)

### WATER PUMP (ELECTRIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Connector broken .....	A	.. Require repair or replacement.
Connector (Weatherpack type) leaking .....	A	.. Require repair or replacement.
Connector melted .....	A	..... (1) Require repair or replacement.
Connector missing .....	C	..... Require replacement.
Inoperative .....	A	..... (2) Require replacement.
Leaking .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.
Noisy .....	2	..... Suggest replacement.
Rotation incorrect for application .....	B	.. Require repair or replacement.
Terminal broken .....	A	.. Require repair or replacement.

Terminal burned, affecting performance .....	A	.....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A	..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2	..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B	..	Require repair or replacement.
Terminal loose, not affecting performance ..	1	..	Suggest repair or replacement.
Vibration .....	1	.....	Suggest replacement.
Wire lead conductors exposed .....	B	..	Require repair or replacement.
Wire lead corroded .....	A	..	Require repair or replacement.
Wire lead open .....	A	..	Require repair or replacement.
Wire lead shorted .....	A	..	Require repair or replacement.

- (1) - Determine cause and correct prior to repair or replacement of part.  
(2) - Check fan motor/controls. Inoperative includes intermittent operation or out of OEM specification.

## WATER PUMPS (NON-ELECTRIC)

### WATER PUMP (NON-ELECTRIC) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require repair or replacement of hardware.
Attaching hardware corroded .....	A	... Require repair or replacement of hardware.
Attaching hardware missing .....	C	..... Require replacement of hardware.
Attaching hardware not functioning .....	A	... Require repair or replacement of hardware.
Corrosion (internal) is excessive, affecting performance .....	A	..... Require replacement.
Corrosion (internal) is excessive, not affecting performance .....	2	. Suggest cooling system service.
Inoperative .....	A	..... (1) Require replacement.
Leaking .....	A	..... Require replacement.
Noisy .....	A	..... Require replacement.
Rotation incorrect for application .....	B	.. Require repair or replacement.
Shaft bent .....	A	..... Require replacement.

- (1) - Inoperative includes intermittent operation or out of OEM specification.

## WIRING HARNESSES AND CONNECTORS

# WIRING HARNESS AND CONNECTOR INSPECTION

Condition	Code	Procedure
Application incorrect ...	B ..	Require repair or replacement.
Attaching hardware broken .....	A ...	Require repair or replacement of hardware.
Attaching hardware missing .....	C .....	Require replacement of hardware.
Attaching hardware not functioning .....	A ...	Require repair or replacement of hardware.
Connector broken .....	A ..	Require repair or replacement.
Connector (Weatherpack type) leaking .....	A ..	Require repair or replacement.
Connector melted .....	A .....	(1) Require repair or replacement.
Connector missing .....	C .....	Require replacement.
Insulation damaged, conductors exposed .....	A ..	Require repair or replacement.
Insulation damaged, conductors not exposed ..	1 .....	Suggest replacement.
Open .....	A ..	Require repair or replacement.
Protective shield (conduit) melted .....	2 .....	(1) Suggest repair or replacement.
Protective shield (conduit) missing .....	2 ..	Suggest repair or replacement.
Resistance (voltage drop) out of specification ...	A ..	Require repair or replacement.
Routed incorrectly .....	B .....	Require repair.
Secured incorrectly .....	B .....	Require repair.
Shorted .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal burned, affecting performance .....	A .....	(1) Require repair or replacement.
Terminal burned, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal corroded, affecting performance ..	A ..	Require repair or replacement.
Terminal corroded, not affecting performance ..	2 ..	Suggest repair or replacement.
Terminal loose, affecting performance .....	B ..	Require repair or replacement.
Terminal loose, not affecting performance ..	1 ..	Suggest repair or replacement.
Voltage drop out of specification .....	A ..	Require repair or replacement.
(1) - Determine cause and correct prior to repair or replacement of part.		

# **\* EXHAUST SYSTEM UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

Exhaust Systems Motorist Assurance Program  
Standards For Automotive Repair

All Makes and Models

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

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## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW OF MOTORIST ASSURANCE PROGRAM**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles—through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt (1) a Pledge of Assurance to their Customers and (2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication



Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

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January 1999

## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS AND SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is

required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

**Example:**

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

**Example:**

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

**Example:**

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

**Example:**

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

**Reasons to Require Repair or Replacement**

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

**NOTE:** When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

**Reasons to Suggest Repair or Replacement**

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

**NOTE:** Suggested services are always optional. When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

## EXHAUST

### SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

**WARNING:** Federal EPA rules prohibit altering an exhaust system in any way that defeats the emission reduction components of a vehicle. Be sure to review and adhere to EPA policy on removing and replacing catalytic converters. Where state or local laws are stricter, they take precedence over these guidelines.

**NOTE:** Some exhaust systems are of a welded design. It is not required that the entire system be replaced. Determine the need to replace individual components based on conditions of component.

## CATALYTIC CONVERTERS

**CAUTION:** Before working on an exhaust system, review EPA regulations on removing and replacing catalytic converters.

**NOTE:** Any time a converter has failed, further diagnosis is required to determine the reason(s) for converter failure.

### CATALYTIC CONVERTER INSPECTION

Condition	Code	Procedure
Air injection tube broken .....	A ...	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube burnt .....	A ...	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube leaking .....	A ...	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube		

loose .....	A	...	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube restricted .....	A	...	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube threads damaged .....	A	...	Require repair or replacement of injection tube or replacement of catalytic converter.
Air injection tube threads stripped (threads missing) .....	A	...	Require repair or replacement of injection tube or replacement of catalytic converter.
Body cracked .....	B	..	Require repair or replacement.
Converter empty .....	A	..	Require repair or replacement.
Converter fill plug missing .....	C	..	Require repair or replacement.
Converter missing .....	C	.....	Require replacement.
Exhaust gases leaking ...	A	..	Require repair or replacement.
Flanges leaking .....	A	...	Require repair or replacement of flanges.
Inlet pipes cracked .....	B	..	Require repair or replacement.
Internal rattle (except pellet-type) .....	2	.....	(1) Further inspection required.
Mounting brackets that are part of converter broken .....	A	..	Require repair or replacement.
Obvious overheating .....	..	.....	(2) Require testing of converter.
Outlet pipes cracked ....	B	..	Require repair or replacement.
Pieces of catalyst material found downstream .....	1	.....	Suggest replacement.
Plugged .....	A	.....	(3) Require replacement.
Testing has determined that existing converter has been lead-poisoned, contaminated, or failed testing .....	A	..	Require repair or replacement.
(1) - If the converter is breaking up, suggest converter replacement. If an object has fallen into the converter, remove the object. (2) - Overheating is caused by something other than the converter. Further diagnosis is required to determine the cause of the overheating. (3) - Determine cause and correct to ensure that new converter will not become plugged.			

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## EXHAUST AND TAIL PIPES

NOTE: For pipes with resonators, also see MUFFLERS AND RESONATORS.

EXHAUST AND TAIL PIPE INSPECTION

Condition	Code	Procedure
Bracket broken .....	A ..	Require repair or replacement.
Pipe bent out of position .....	B ..	Require repair or replacement.
Pipe broken .....	A ..	Require repair or replacement.
Pipe cracked .....	B ..	Require repair or replacement.
Pipe leaking .....	A .....	Require replacement.
Pipe missing .....	C .....	Require replacement.
Pipe plugged .....	A .....	Require replacement.
Pipe weak due to corrosion, but no leaks present .....	1 .....	Suggest replacement.
Weld broken .....	A ..	Require repair or replacement.

## EXHAUST CONNECTIONS

### EXHAUST CONNECTION INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	B .....	Require replacement of hardware.
Clamp broken .....	A .....	Require replacement.
Clamp loose .....	A .	Require repair or replacement.
Clamp missing .....	C .....	Require replacement.
Corroded, affecting structural integrity ...	1 .....	Suggest replacement.
Incorrect type (i.e. flange, ball & socket etc.) .....	B .....	Require replacement.
Leaking .....	A .....	Require repair.
Loose .....	A .....	Require repair.

## HANGERS

### HANGER INSPECTION

Condition	Code	Procedure
Broken .....	A .....	Require replacement.
Corroded, affecting structural integrity ...	1 .....	Suggest replacement.
Incorrect type .....	B .....	Require replacement.
Loose .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.
Out of position .....	B ..	Require repair or replacement.
Rubber deteriorated .....	1 .....	Suggest replacement.

## HEAT RISERS (MECHANICAL EFE DEVICES)

### HEAT RISER (MECHANICAL EFE DEVICE) INSPECTION

Condition	Code	Procedure
Broken .....	A .....	Require replacement of affected parts.
Diaphragm inoperative ...	A .....	(1) Require replacement.

Leaking .....	A	..	Require repair or replacement.
Noisy .....	2	...	Suggest repair or replacement of affected parts.
Seized .....	A	...	Require repair or replacement of affected parts.
Spring broken .....	B	.....	Require replacement of spring(s).
Spring inoperative .....	A	.....	Require replacement of spring(s).

(1) - If the inoperative diaphragm is separate from the heat riser, then require replacement of the inoperative diaphragm. If the inoperative diaphragm is part of the heat riser, then replace the heat riser.

## HEAT SHIELDS

### HEAT SHIELD INSPECTION

Condition	Code	Procedure
Bent .....	B	.. Require repair or replacement.
Broken .....	A	..... Require replacement.
Corroded, affecting structural integrity ...	1	..... Suggest replacement.
Loose .....	A	.. Require repair or replacement.
Missing .....	C	..... Require replacement.

## MANIFOLDS (CAST AND TUBE TYPE)

### MANIFOLD (CAST AND TUBE TYPE) INSPECTION

Condition	Code	Procedure
Air injection tube in manifold broken .....	A	... Require repair or replacement of injection tube or replacement of manifold.
Air injection tube in manifold corroded, affecting structural integrity .....	1	..... Suggest replacement of injection tube or manifold.
Air injection tube in manifold leaking .....	A	... Require repair or replacement of injection tube or replacement of manifold.
Air injection tube in manifold loose .....	A	..... Require repair.
Air injection tube in manifold restricted ....	A	..... Require replacement of injection tube or manifold.
Air injection tube in manifold threads damaged .....	A	..... Require repair of injection tube or manifold.
Air injection tube in manifold threads stripped (threads missing) .....	A	..... Require replacement of injection tube or manifold.
Bolt broken .....	A	... Require replacement of bolts.

Bolt loose .....	A	.....	Require tightening or replacement of bolts.
Bolt missing .....	C	...	Require replacement of bolts.
Corroded, affecting sealability .....	A	..	Require repair or replacement.
Cylinder head threads stripped .....	A	...	Require repair or replacement of cylinder head.
Gasket leaking .....	A	.....	Require tightening or replacement of gasket.
Heat stove bent .....	B	.....	(1) Require repair or replacement of stove.
Heat stove broken .....	A	.....	(1) Require replacement of stove.
Heat stove corroded, affecting structural integrity .....	1	.....	(1) Suggest replacement of stove.
Heat stove missing .....	C	.....	(1) Require replacement of stove.
Manifold broken .....	A	..	Require repair or replacement.
Manifold cracked .....	B	..	Require repair or replacement.
Manifold warped .....	A	..	Require repair or replacement.
Out of specification ....	B	..	Require repair or replacement.
Stud broken .....	A	....	Require replacement of stud.
Stud missing .....	C	....	Require replacement of stud.
Stud threads damaged ....	A	...	Require repair or replacement of stud.
Stud threads stripped (threads missing) .....	A	....	Require replacement of stud.
(1) - Stove may not be available separately; this may require replacement of manifold.			

## MECHANICAL EFE DEVICES

See HEAT RISERS (MECHANICAL EFE DEVICES) .

## MUFFLERS AND RESONATORS

### MUFFLER AND RESONATOR INSPECTION

Condition	Code	Procedure
Body shell distorted, affecting performance or structural integrity ...	A	..... Require replacement.
Corrosion hole .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Mounting bracket broken .	A	.. Require repair or replacement.
Mounting bracket cracked .....	B	.. Require repair or replacement.
Nipple cracked .....	A	.. Require repair or replacement.
Nipple loose .....	B	..... Require replacement.
Outer wrap peeling (exhaust not leaking) ..	1	..... Suggest replacement.
Plugged .....	A	..... Require replacement.
Puncture (other than a drain hole) .....	A	..... Require replacement.
Rattling or knocking noise from inside muffler ....	B	..... Require replacement.
Seam open (exhaust		

leaking) .....	A	.....	Require replacement.
Sound quality			
unsatisfactory .....	2	..	Suggest replacement to address customer need and/or request.
Split (exhaust leaking) .	A	.....	Require replacement.
Weak due to corrosion, but			
no leaks present .....	1	.....	Suggest replacement.

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# F - BASIC TESTING - 2.5L & 4.0L

## 1993 Jeep Cherokee

### 1993 ENGINE PERFORMANCE

Chrysler Corp. 2.5L & 4.0L Basic Diagnostic Procedures

Jeep; Cherokee, Grand Cherokee, Wrangler

## INTRODUCTION

The following diagnostic steps will help prevent overlooking a simple problem. This is also where to begin diagnosis for a no-start condition.

The first step in diagnosing any driveability problem is verifying the customer's complaint with a test drive under the conditions the problem reportedly occurred.

Before entering self-diagnostics, perform a careful and complete visual inspection. Most engine control problems result from mechanical breakdowns, poor electrical connections or damaged/misrouted vacuum hoses. Before condemning the computerized system, perform each test listed in this article.

**NOTE:** Unless stated otherwise in test procedure, perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) having a minimum 10-megohm input impedance.

## PRELIMINARY INSPECTION & ADJUSTMENTS

### VISUAL INSPECTION

Visually inspect all electrical wiring, looking for chafed, stretched, cut or pinched wiring. Ensure electrical connectors fit tightly and are not corroded. Ensure vacuum hoses are properly routed and are not pinched or cut. See M - VACUUM DIAGRAMS article in the ENGINE PERFORMANCE Section to verify routing and connections. Inspect air induction system for possible vacuum leaks.

### MECHANICAL INSPECTION

#### Compression

Check engine mechanical condition with a compression gauge, vacuum gauge or engine analyzer. See engine analyzer manual for specific instructions.

**WARNING:** DO NOT use ignition switch during compression tests on fuel injected vehicles. Crank engine with a remote starter. Fuel injectors on many models are triggered by ignition switch during cranking mode, which can create a fire hazard or contaminate the engine's oiling system.

#### COMPRESSION RATIO TABLE

Application		Specification
2.5L	.....	9.1:1
4.0L	.....	8.8:1
5.2L	.....	9.1:1

**NOTE:** Compression pressure and cylinder pressure variation are not available from manufacturer.

#### Exhaust System Backpressure

The exhaust system can be checked with a vacuum or pressure gauge. Remove O2 sensor. Connect a 0-5 psi pressure gauge and run engine at 2500 RPM. If exhaust system backpressure is greater than 1 3/4 - 2 psi, exhaust system or catalytic converter is plugged.

If a vacuum gauge is used, connect vacuum gauge hose to intake manifold vacuum port and start engine. Observe vacuum gauge. Open throttle part way and hold steady. If vacuum gauge reading slowly drops after stabilizing, check exhaust system for restriction.

## FUEL SYSTEM

### FUEL PRESSURE

Basic diagnosis of fuel system should begin with determining fuel system pressure.

**WARNING:** ALWAYS relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components.

#### Fuel System Pressure Release

Disconnect negative battery cable. Remove fuel filler cap. Remove cap from pressure test port on fuel rail. Position shop towels to soak up any spilled fuel. Using a small screwdriver or pin punch, push test port valve in to relieve fuel pressure. See Fig. 1. Install cap over test port. Reconnect negative battery cable.

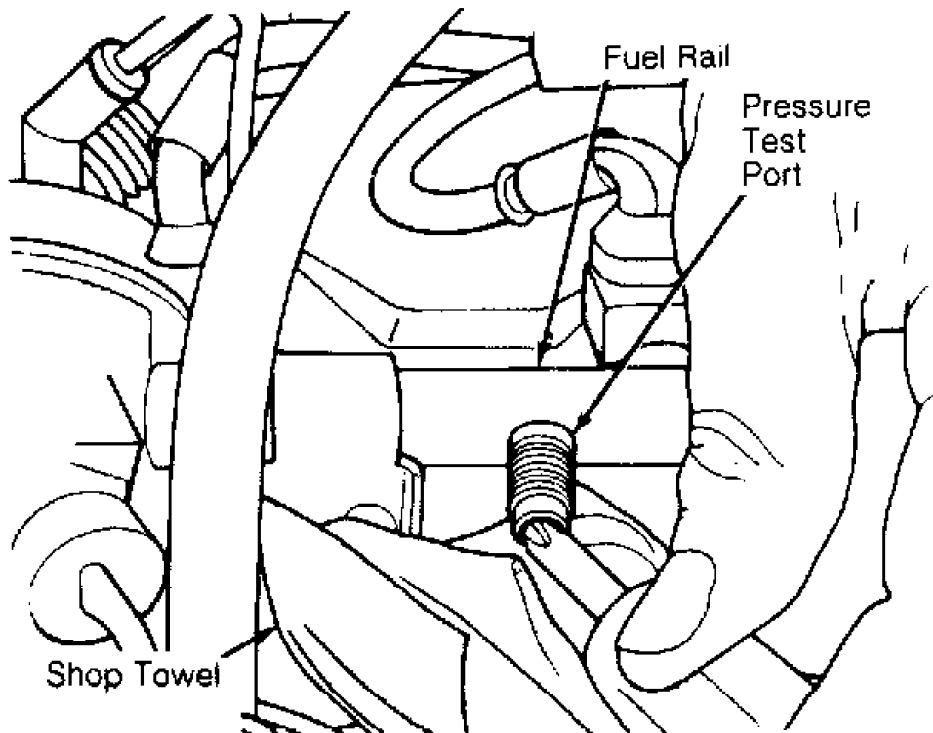


Fig. 1: Releasing Fuel System Pressure  
Courtesy of Chrysler Corp.

#### Deadhead Pressure

- 1) Relieve fuel system pressure. See FUEL SYSTEM PRESSURE

RELEASE. Connect a 0-60 psi (0-4.2 kg/cm<sup>2</sup>) fuel pressure gauge to the pressure test port fitting on fuel rail.

2) Remove fuel pump relay (located in power distribution center). Using a jumper wire, connect terminals No. 30 and 87. See Fig. 2. Note fuel pressure gauge reading, and momentarily pinch off fuel return line.

3) Fuel pressure should be at least 53 psi (3.7 kg/cm<sup>2</sup>). DO NOT allow pressure to exceed 60 psi (4.2 kg/cm<sup>2</sup>). Release fuel return line.

#### Fuel System Pressure Test

1) Relieve fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE. Connect a 0-60 psi (0-4.2 kg/cm<sup>2</sup>) fuel pressure gauge to the pressure test port fitting on fuel rail.

2) Remove vacuum line from fuel pressure regulator. Start vehicle and note gauge reading. Reconnect vacuum line and note gauge reading. See FUEL SYSTEM PRESSURE SPECIFICATIONS table. Ensure pressure readings are as specified. If fuel pressure is not higher with vacuum line disconnected, inspect pressure regulator vacuum line for cause of no vacuum.

3) If fuel pressure is high, inspect fuel return line for kinks and blockage. If fuel pressure is low, momentarily pinch off fuel return line. If pressure remains low, inspect fuel supply line, fuel filter and fuel rail inlet for blockage. If pressure rises, replace fuel pressure regulator.

#### FUEL SYSTEM PRESSURE SPECIFICATIONS TABLE

Application	psi (kg/cm <sup>2</sup> )
Vacuum Line Disconnected .....	39 (2.7)
Vacuum Line Connected .....	31 (2.2)

#### Fuel System Rest Pressure

1) Relieve fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE. Connect a 0-60 psi (0-4.2 kg/cm<sup>2</sup>) fuel pressure gauge to the pressure test port fitting on fuel rail. Start engine and note reading on pressure gauge. Shut engine off.

2) Wait 30 minutes and check fuel pressure. Fuel pressure should be within 20 psi (1.4 kg/cm<sup>2</sup>) of first reading. If pressure is not as indicated, check fuel system for leaks at fuel pressure regulator, fuel pump check valve or fuel injectors.

#### Capacity (Volume) Test

1) Relieve fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE. Disconnect fuel line on fuel rail. Place fuel line into a graduated container.

2) Remove fuel pump relay (located in power distribution center). Using a jumper wire, connect terminals No. 30 and 87. See Fig. 2. Volume of fuel should be 1.05 qts. (1.0L) in one minute. If fuel volume is not as specified, check for a plugged fuel filter or fuel pump inlet sock.

#### Fuel Pump Relay

1) Disconnect negative battery cable. Remove Powertrain Control Module (PCM) harness connector. Reconnect battery cable. Turn ignition on. Check for voltage at Dark Blue/Yellow wire on Cherokee and Wrangler or Pink wire on Grand Cherokee in PCM harness connector. If voltage is not present, go to step 4). If voltage is present, ground the wire. Fuel pump should work.

2) If fuel pump does not work, check if relay clicks. If relay does not click, go to step 5). If relay clicks, ensure voltage

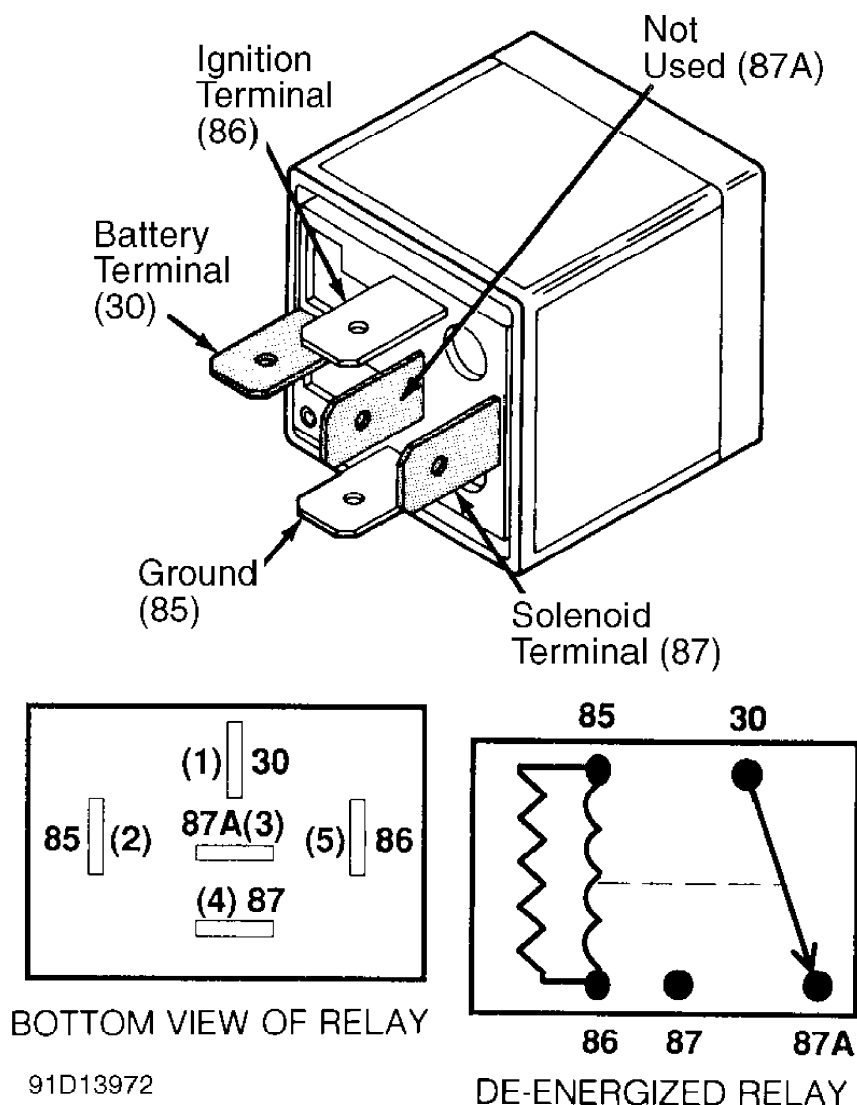
is present at relay terminals No. 30 (battery) and 87 (fuel pump), and at fuel pump. See Fig. 2.

3) If fuel pump still does not work, check ballast resistor (Cherokee only) and fuel pump ground. If ballast resistor and ground are okay, replace fuel pump.

4) If no voltage is present, ensure wire has continuity to fuel pump relay terminal No. 85. Ensure voltage (from ignition switch) is present at relay terminal No. 86. See Fig. 2.

5) If all circuits are okay or fuel pump relay did not click in step 2), check resistance between relay terminals No. 86 and 85. See Fig. 2. Resistance should be 70-80 ohms. If resistance is not 70-80 ohms, replace relay.

6) Disconnect negative battery terminal. Reconnect PCM harness connector. Connect battery cable. Check fuel pump operation. If fuel pump does not operate, see G - 2.5L & 4.0L TESTS W/CODES article in the ENGINE PERFORMANCE Section and check PCM.



91D13972  
Fig. 2: Identifying Fuel Pump Relay Terminals  
Courtesy of Chrysler Corp.

## IGNITION CHECKS

## SECONDARY SPARK

### Spark Test

1) Remove coil wire from distributor cap. Hold end of cable about 1/4" from ground. Crank engine. Spark should be present and constant. If spark is not present and constant, check coil and coil wire resistance. Perform IGNITION PRIMARY test under IGNITION CHECKS.

2) If coil wire spark is present, ensure spark reaches spark plugs. Check condition of rotor, cap, spark plug wires and spark plugs. Repair or replace if necessary.

### Spark Plug & Coil Wire Resistance

Resistance should be 250-1000 ohms per inch.

### Ignition Coil Resistance Test

1) Remove primary and secondary leads from ignition coil. Using ohmmeter, check primary resistance between positive and negative terminals of coil. See IGNITION COIL RESISTANCE table.

2) Check secondary resistance between center tower and negative terminal of coil. See IGNITION COIL RESISTANCE table. Replace coil if readings are not within specification.

### IGNITION COIL RESISTANCE TABLE- Ohms @ 75°F (24°C)

Application	Ohms
Primary Diamond .....	.97-1.18
Toyodenso .....	.95-1.20
Secondary	
Diamond .....	11,300-15,300
Toyodenso .....	11,300-13,300

## IGNITION PRIMARY

NOTE: Perform SECONDARY SPARK under IGNITION CHECKS before proceeding with test.

1) Ensure battery has a minimum of 12.5 volts (9.5 cranking volts) available to operate cranking system. Ensure battery cable connections are clean and tight.

2) Using an analog voltmeter, backprobe the following wires at the distributor. Touch positive lead to Tan/Yellow wire (Gray/Black wire Grand Cherokee). Touch negative lead to Black/Light Blue wire.

3) Set voltmeter to 15-volt DC scale. Crank engine. If voltmeter needle does not fluctuate between 0-5 volts, check related circuits. If necessary, replace camshaft position sensor. If camshaft position sensor is okay, but engine does not start, see G - 2.5L & 4.0L TESTS W/CODES article in the ENGINE PERFORMANCE Section and check PCM.

## SUMMARY

If no faults were found while performing BASIC DIAGNOSTIC PROCEDURES, proceed to G - 2.5L & 4.0L TESTS W/CODES article in the ENGINE PERFORMANCE Section. If no hard codes are found in G - 2.5L & 4.0L TESTS W CODES, proceed to H - TESTS W/O CODES article in the ENGINE PERFORMANCE Section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.) or intermittent diagnostic procedures.



# FUSES & CIRCUIT BREAKERS

1993 Jeep Cherokee

Fuses & Circuit Breakers  
1993-95 Jeep

Jeep; Cherokee

## IDENTIFICATION

### FUSES & CIRCUIT BREAKERS

The fuse block is to the left of the steering column, under the instrument panel.

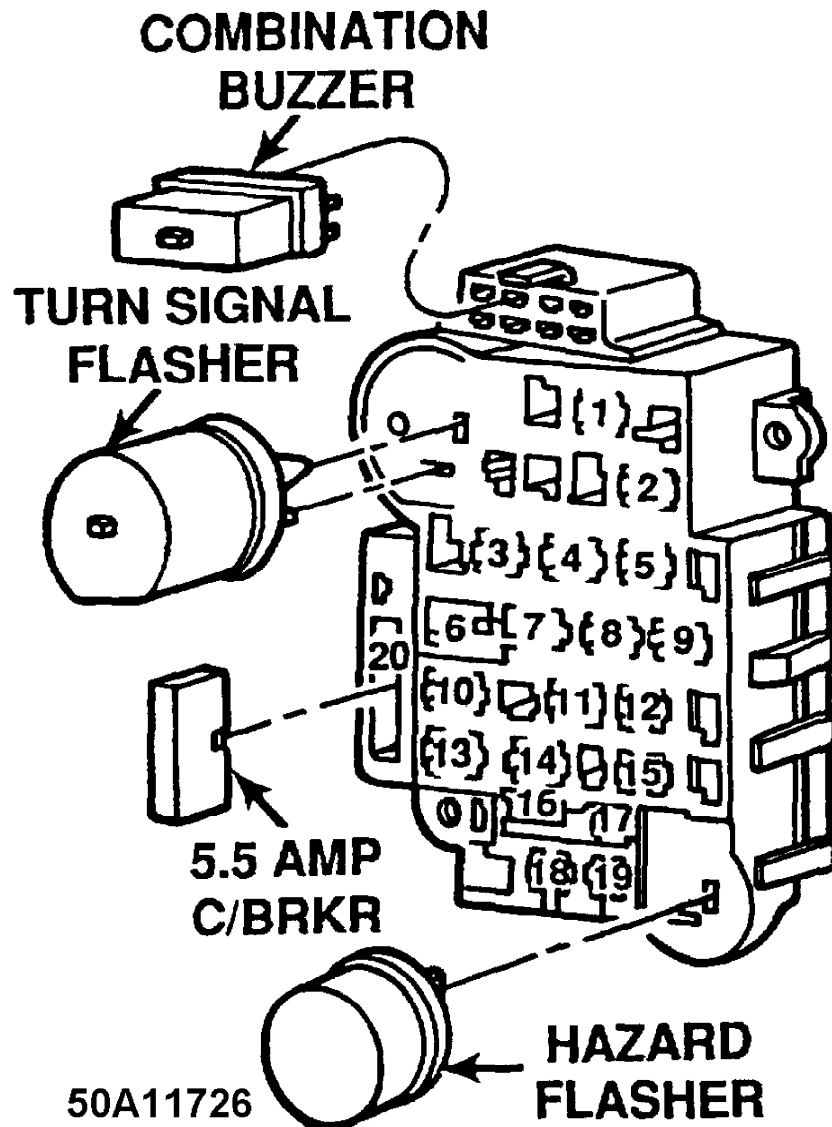


Fig. 1: Fuse Panel Identification (1993-95)  
Courtesy of Chrysler Corp.

FUSE & CIRCUIT BREAKER I.D. (PASSENGER COMPARTMENT)

1 - 25 Amp (Natural)  
Rear Window Wiper, Washer.

2 - 15 Amp (Lt. Blue)  
Radio, Cigar Lighter, Dome Lamp (1993).

3 - Not Used  
Not Used.

4 - 15 Amp (Lt. Blue)  
Flash to Pass.

5 - 25 Amp (Natural) (1992)  
Blower Motor.

6 - 30 Amp (Circuit Breaker)  
Power Windows.

7 - 2 Amp (Pink)  
Antilock Brakes (ABS).

8 - 20 Amp (Yellow)  
Turn Signal Flasher.

9 - 10 Amp (Red)  
Radio/Clock & Memory, Courtesy Lights, Glove Box, Cargo, Dome  
Lamps, Telltales.

10 - Not Used  
Not Used.

11 - 25 Amp (Natural)  
Headlamp Delay Module, Horns.

12 - Not Used  
Not Used.

13 - 20 Amp (Yellow)  
Power Door Locks.

14 - Not Used  
Not Used.

15 - 15 Amp (Lt. Blue)  
Instrument Panel Lamps, Clock, Radio/Clock & Memory, Headlamp  
Switch, Parking Lamps.

16 - 30 Amp (Circuit Breaker)  
Power Seats, Trailer Tow.

17 - 7.5 Amp (Violet)  
Instrument Cluster Guages, Headlamp Delay Module, Chime  
Module, Overhead Console.

18 - 25 Amp (Natural)  
Heated Rear Window.

19 - 5 Amp (Tan)  
Instrument Panel Lamps, Radio Illumination.

20 - 5.5 Amp (Circuit Breaker)  
Windshield Wiper/Windshield Washer.



## RELAY PANEL IDENTIFICATION (1993-95 MODELS)

The relay panel is to the right of the steering column, under the instrument panel.

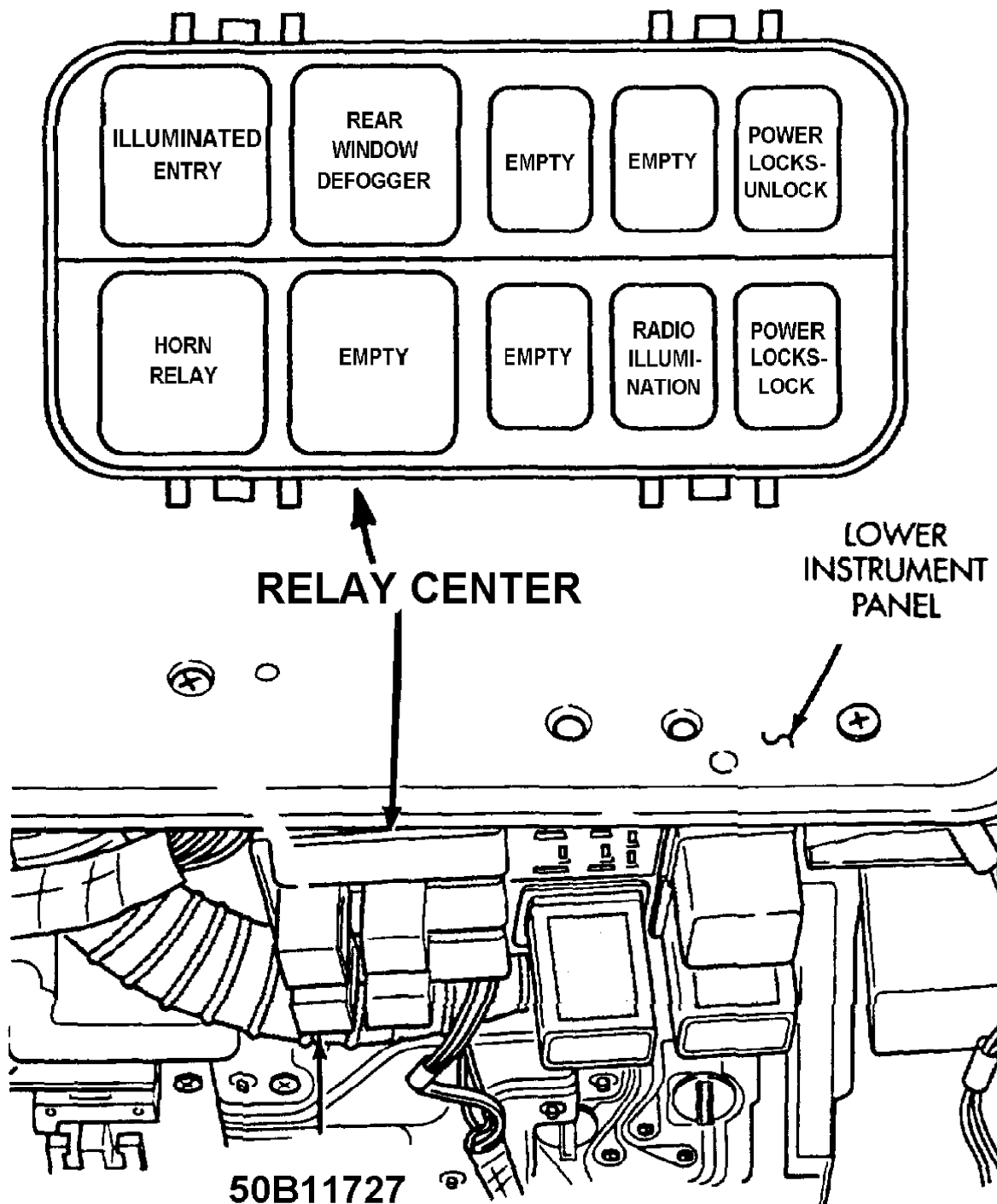


Fig. 2: Relay Block Identification (1993-95 Models)  
Courtesy of Chrysler Corp.

## RELAY IDENTIFICATION (PASSENGER COMPARTMENT)

1 - Illuminated Entry Relay (1993-94); Not Used (1995)  
No additional definition.

2 - Horn Relay (1993-94); Dual Flasher Relay (1995)  
No additional definition.

3 - Rear Window Defogger Relay  
No additional definition.

4 - Not Used  
No additional definition.

5 - Not Used (1993-94); Horn Relay (1995)  
No additional definition.

6 - Not Used  
No additional definition.

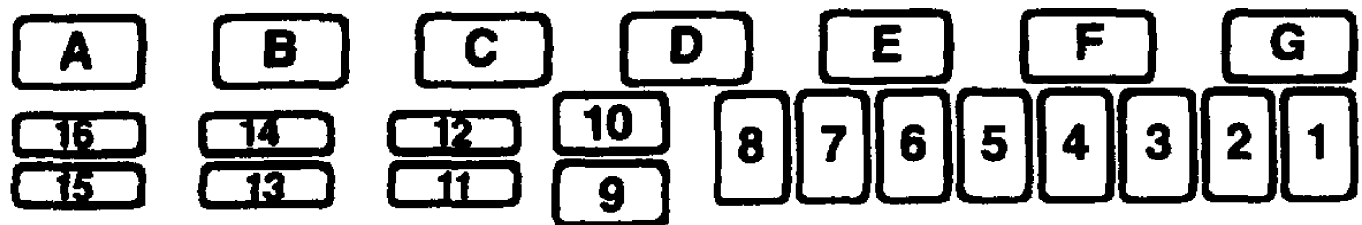
7 - Not Used  
No additional definition.

8 - Radio Illumination Relay  
No additional definition.

9 - Power Door Lock (Unlock) Relay  
No additional definition.

10 - Power Door Lock (Lock) Relay  
No additional definition.

#### POWER DISTRIBUTION CENTER IDENTIFICATION (1993-95)



50C11652

Fig. 3: Power Distribution Center Identification (1993-95)  
Courtesy of Chrysler Corp.

**WARNING:** Always disconnect battery ground cable before servicing "high-current" fuses. It is recommended that "high-current" fuses be replaced by a qualified technician.

#### FUSE & CIRCUIT BREAKER I.D. (POWER DISTRIBUTION)

1 - 60 Amp (Blue)  
Generator Output.

2 - 30 Amp (Green)  
Engine Control (ECU) - Fuel Pump, Injectors, Ignition Coil,  
Oxygen Sensors, Generator Field, Engine Controller Automatic  
Transmission Controller (ATCU).

3 - 40 Amp (Orange)  
Fuse Block.

4 - 20 Amp (Yellow)

Hazard Lamps.

5 - 40 Amp (Orange)  
Headlamp Switch.

6 - 50 Amp (Red)  
Ignition Switch - Engine Controller, Fuel Pump Relay,  
Automatic Shutdown Relay Coil.

7 - 40 Amp (Orange)  
Heated Rear Window, Starter Solenoid.

8 - 40 Amp (Orange)  
ABS Pump Motor.

9 - 60 Amp (Blue)  
Generator Output.

10 - 30 Amp (Green)  
ABS System.

11 - 15 Amp (Blue)  
Ignition Switch - Back-up Lamps, A/C Relay Coil, Shift  
Selector, Speed Control, Aux. Cooling Fan Relay Coil.

12 - 10 Amp (Red)  
Automatic Transmission.

13 - 15 Amp (Blue)  
Auxilliary Lamps - Fog Lamps, Underhood Lamps.

14 - 20 Amp (Yellow)  
Engine Controller.

15 - 20 Amp (Yellow)  
Aux. Cooling Fan.

16 - 10 Amp (Red)  
Ignition Off Draw (1993), Radio/Clock Memory, Ignition Off  
Draw, Dome Courtesy (1994-95).

## RELAY IDENTIFICATION (POWER DISTRIBUTION)

- \* A - Aux. Cooling Fan Relay
- \* B - Fuel Pump Relay
- \* C - ABS Pump Relay
- \* D - Air Conditioning Relay
- \* E - Auto Shutdown Relay
- \* F - Starter Relay
- \* G - ABS System Relay

## CAUTIONS & WARNINGS

### BATTERY

**WARNING:** When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See the COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section.

## SUPPLEMENTAL RESTRAINT (AIR BAG SYSTEM) (IF EQUIPPED)

WARNING: The Diagnostic Energy Reserve Module (DERM) can maintain enough voltage to cause a deployment of the Inflator Module for up to 10 minutes after the Ignition Switch is turned off and the battery is disconnected. Many of the service procedures require disconnection of the Inflator Module to avoid an accidental deployment.

# G - AUTO TRANS DIAGNOSIS - 4.0L MODELS W/AW4

## 1993 Jeep Cherokee

AUTOMATIC TRANSMISSIONS  
Aisin Warner 4 Electronic Diagnosis  
1993-94 Cherokee

### APPLICATION

NOTE: Transmission may also be referred to as AW-4.

#### APPLICATION

Model	Trans.
1993-94 Cherokee (1)	AW-4

(1) - Used on vehicles with 4.0L 6-cylinder engine only for 1993-94 model years.

NOTE: Vehicle body code may be required when diagnosing or repairing transmission, as body code may be used instead of vehicle model name. See BODY CODE DESIGNATION table.

#### BODY CODE DESIGNATION

Vehicle Model	Body Code
Cherokee	XJ

### DESCRIPTION

The electronic control system for the AW-4 transmission controls transmission shift points and torque converter lock-up. Electronic control system consists of Transmission Control Module (TCM), valve body solenoids, throttle position sensor, speed sensor, neutral safety switch and brake switch.

NOTE: Transmission Control Module (TCM) may be referred to as Transmission Control Unit (TCU). Neutral safety switch may be referred to as park/neutral safety switch or gear select switch.

### OPERATION

#### TRANSMISSION CONTROL MODULE (TCM)

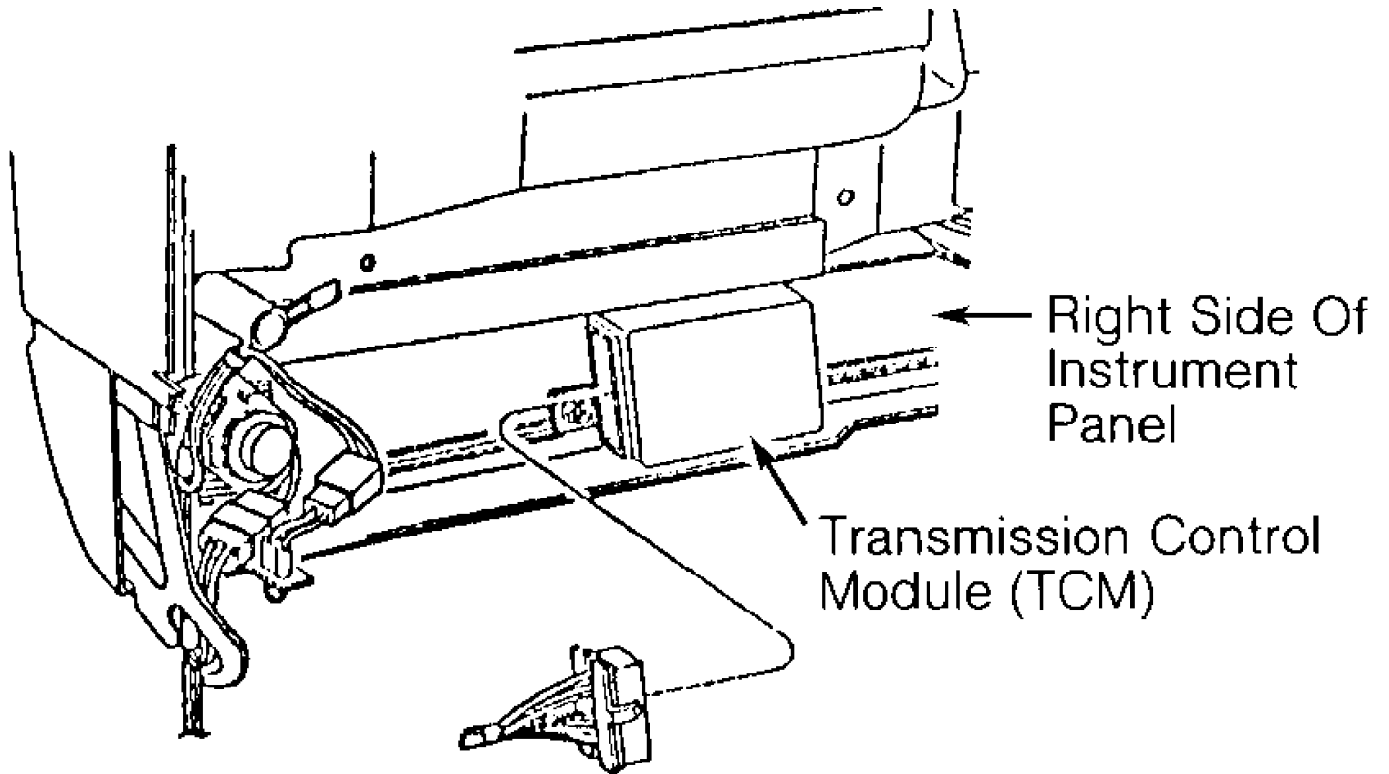
The TCM determines shift points and torque converter lock-up based on input signals received from throttle position sensor, neutral safety switch, speed sensor and brake switch. The TCM controls transmission shift points and torque converter lock-up by operating electric solenoids mounted on the valve body.

The TCM contains a self-diagnostic system used for determining an electronic component failure. The TCM self-diagnostic system will store a diagnostic trouble code in the TCM memory if certain electronic problems exist. If electronic problem goes away, diagnostic trouble code will be erased from TCM memory after ignition has been cycled approximately 75 times.

NOTE: Diagnostic trouble code may be referred to as fault code.

Diagnostic trouble codes can be retrieved using a Diagnostic Readout Box-II (DRB-II). After repairing an electrical system problem, stored diagnostic trouble code must be cleared from TCM memory.

The TCM is located behind right side of instrument panel on Cherokee. See Fig. 1.



94F38401

Fig. 1: Transmission Control Module (TCM) I.D. (Cherokee)  
Courtesy of Chrysler Corp.

## VALVE BODY SOLENOIDS

Valve body solenoids, mounted on the valve body, are output devices controlled by signals received from the TCM. See Fig. 2. The No. 1 and 2 valve body solenoids control transmission shifts while the No. 3 valve body solenoid is used for torque converter lock-up.

When No. 1 and 2 valve body solenoids are energized, solenoid plunger moves from seat. This opens the drain port and releases line pressure. When either valve body solenoid is de-energized, plunger closes the drain port.

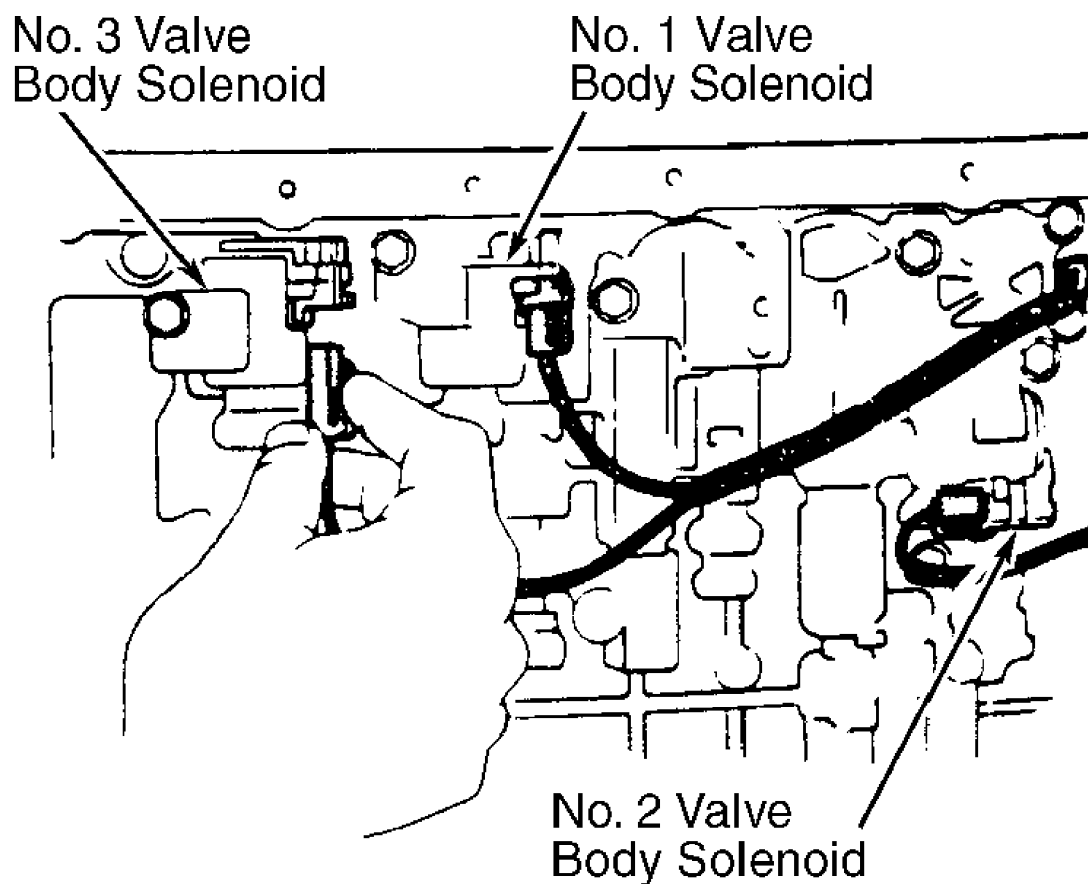
The No. 3 valve body solenoid operates in reverse. When No. 3 valve body solenoid is de-energized, solenoid plunger moves away from seat. This opens the drain port and releases line pressure. When No. 3 valve body solenoid is energized, the plunger closes the drain port.

NOTE: For valve body solenoid usage, see VALVE BODY SOLENOID APPLICATION table.

VALVE BODY SOLENOID APPLICATION (1)

Shifter Position	No. 1 Solenoid	No. 2 Solenoid
"D" (Drive)		
1st Gear	ON	OFF
2nd Gear	ON	ON
3rd Gear	OFF	ON
4th Gear	OFF	OFF
"3"		
1st Gear	ON	OFF
2nd Gear	ON	ON
3rd Gear	OFF	ON
"1-2"		
1st Gear	ON	OFF
2nd Gear	ON	ON
"R" (Reverse)	ON	OFF
"N" Or "P"	ON	OFF

(1) - Valve body contains 3 valve body solenoids. See Fig. 2. No. 1 and 2 valve body solenoids are used for controlling transmission shifts. No. 3 valve body solenoid is used for torque converter lock-up only.



92F13511

Fig. 2: Identifying Valve Body Solenoids  
Courtesy of Chrysler Corp.

BRAKE SWITCH

Brake switch is an input device mounted above the brake pedal. When brake pedal is operated, brake switch delivers an input signal to the TCM. The TCM uses input signal for controlling No. 3 valve body solenoid for torque converter lock-up.

## **NEUTRAL SAFETY SWITCH**

**NOTE:** Neutral safety switch may be referred to as park/neutral safety switch or gear select switch.

Neutral safety switch is an input device mounted on the transmission manual valve shaft. Neutral safety switch delivers an input signal to TCM, indicating transmission manual valve gear position.

## **SPEED SENSOR**

Speed sensor, mounted in adapter housing or extension housing, is an input device consisting of speed sensor rotor and speed sensor. Speed sensor rotor is mounted on transmission output shaft. Input signal is delivered from speed sensor to TCM with each revolution of transmission output shaft. The TCM uses input signal for controlling transmission operation.

## **THROTTLE POSITION SENSOR (TPS)**

The TPS, mounted on throttle body, determines throttle position and delivers an input signal to TCM. The TCM uses input signal for controlling transmission upshifts and torque converter lock-up.

## **SELF-DIAGNOSTIC SYSTEM**

### **DIAGNOSTIC PROCEDURE**

When performing vehicle diagnosis:

- \* Ensure transmission fluid level is correct and fluid is neither contaminated nor aerated.
- \* Ensure shift cable is properly adjusted. Refer to the appropriate TRANSMISSION SERVICING - A/T article in this section.
- \* Ensure battery is fully charged.
- \* Perform visual inspection, ensuring all electrical connections at transmission, TCM, throttle position sensor, neutral safety switch, speed sensor and brake switch are clean and properly installed.
- \* Perform TEST 1A - VERIFICATION OF COMPLAINT under TROUBLE SHOOTING CHARTS in this article.
- \* Repair diagnostic trouble codes in order displayed.
- \* Always perform TEST 2A - VERIFICATION TEST after repair is completed. See TEST 2A - VERIFICATION TEST under TROUBLE SHOOTING CHARTS in this article.

### **RETRIEVING DIAGNOSTIC TROUBLE CODES**

**NOTE:** Manufacturer recommends using Chrysler's Diagnostic Readout Box-II (DRB-II) with proper cartridge for system diagnosis. Other after-market scan tools may be used for system diagnosis. The following procedure is for DRB-II scan tool usage. Use manufacturer's instruction for operating the DRB-II scan tool. When retrieving diagnostic trouble codes



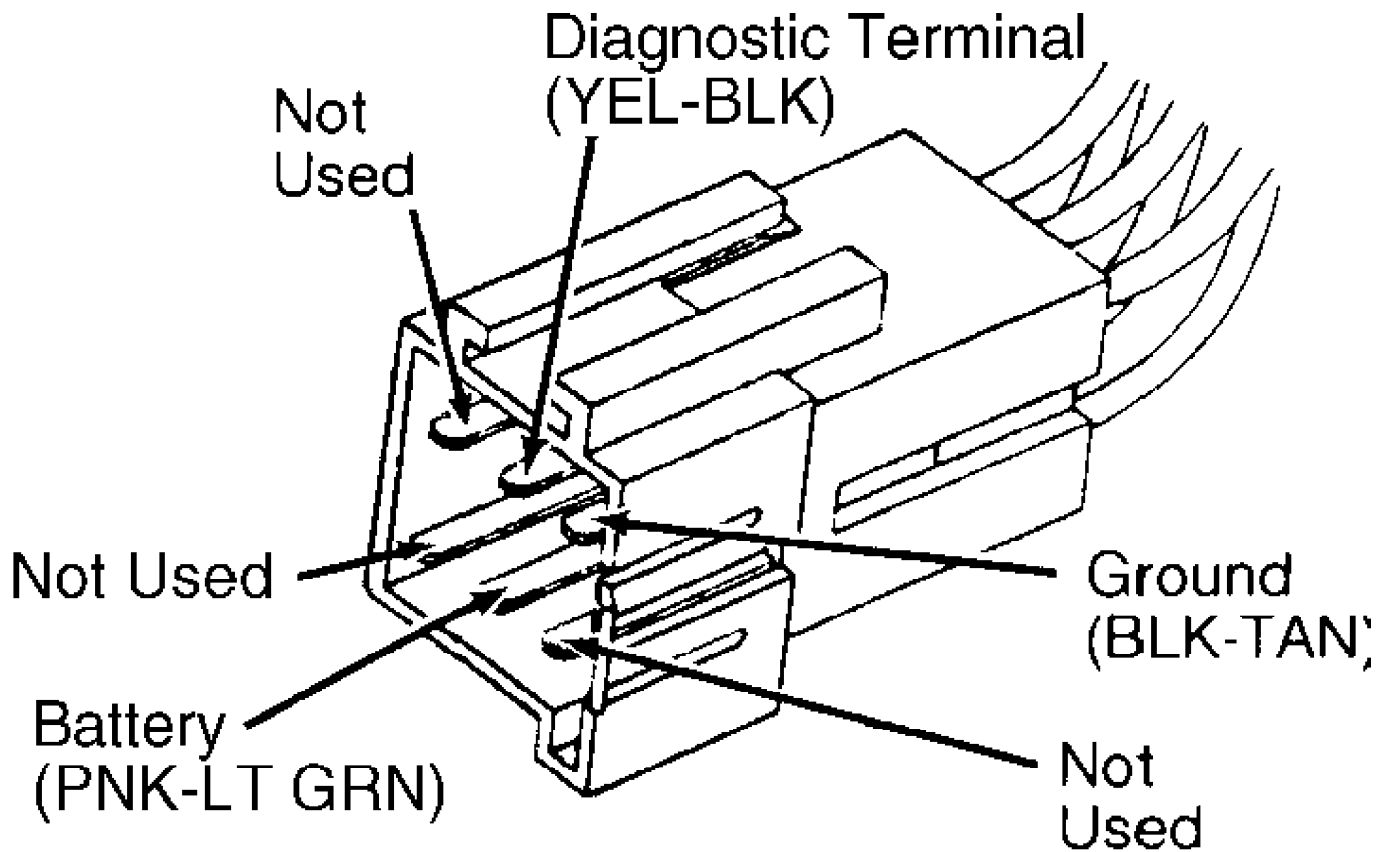
using DRB-II, you must first enter AW4 MENU and then retrieve diagnostic trouble codes.

NOTE: Ensure TEST 1A - VERIFICATION OF COMPLAINT is performed when trouble shooting the vehicle. This test checks for diagnostic trouble codes with vehicle stationary and during road test. See TEST 1A - VERIFICATION OF COMPLAINT under TROUBLE SHOOTING CHARTS.

NOTE: The DRB-II scan tool can be used in several different modes using manufacturer's instructions to activate system components and perform several tests on transmission. See DRB-II OPERATING MODES.

#### Entering AW4 MENU

1) Ensure ignition is off. Connect DRB-II to 6-pin transmission diagnostic connector. See Fig. 3. Transmission diagnostic connector is located on driver's side of instrument panel, above accelerator pedal.



94F38427

Fig. 3: Diagnostic Connector & Terminals I.D. (Cherokee)  
Courtesy of Chrysler Corp.

2) Turn ignition on. Copyright date and diagnostic program will be briefly displayed. If DRB-II displays an error message, proceed to DRB-II PROBLEMS & ERROR MESSAGES. The following are possible error messages that may appear.

- \* CARTRIDGE ERROR
- \* HIGH BATTERY

- \* KEYPAD TEST FAILURE
- \* LOW BATTERY
- \* RAM TEST FAILURE

3) If no error messages appear, display will read as follows after a few seconds: 1) VEHICLES TESTED, 2) HOW TO USE, 3) CONFIGURE and 4) SELECT SYSTEM.

4) Select 4) SELECT SYSTEM to enter diagnostic system. Once in SELECT SYSTEM, select 2) TRANSMISSION to enter transmission. Display will read 1) EATX and 2) AW4.

5) Select 2) AW4. After a few seconds display will change to read AW4, VERSION 01. After a few seconds, display will read AW4 MENU, 1) SYSTEM TEST and 2) READ FAULTS. If DOWN ARROW is depressed 3 times, display will read as follows: 3) STATE DISPLAY, 4) ACTUATOR TESTS and 5) ADJUSTMENTS.

NOTE: The ACTUATOR TESTS and ADJUSTMENTS cannot be used when diagnosing the AW-4 transmission.

#### Retrieving Diagnostic Trouble Codes

1) Select 2) READ FAULTS from AW4 MENU. If no diagnostic trouble code exists, display will read as follows: AW4 FAULTS, NO FAULTS DETECTED.

2) If diagnostic trouble code exists, the following message will be displayed: 1 OF 3 FAULTS. This number will vary depending on number of diagnostic trouble codes stored in the TCM memory.

3) Diagnostic trouble code and message will be displayed. Press DOWN ARROW key to display next diagnostic trouble code. To identify diagnostic trouble code, see DIAGNOSTIC TROUBLE CODE IDENTIFICATION table.

NOTE: See TROUBLE SHOOTING CHARTS to diagnose faults indicated by trouble codes.

NOTE: Valve body solenoid diagnostic trouble code 700 may appear in a FAULT PRESENT or FAULT STORED status. Status will be displayed along with diagnostic trouble code. Diagnostic trouble code must be diagnosed depending on the status. See TEST 1A - VERIFICATION OF COMPLAINT under TROUBLE SHOOTING CHARTS.

#### DIAGNOSTIC TROUBLE CODE IDENTIFICATION

Trouble Code	Problem Area
700 (1)	Valve Body Solenoid
702	Speed Sensor
703	(2) Gear Select Switch
705	Throttle Position Sensor
706	Brake Switch
707	Wrong TCM Or TCU

(1) - Trouble code may apply to individual valve body solenoids. Valve body solenoid may be referred to as S1 for No. 1, S2 for No. 2 and S3 for No. 3.

(2) - Gear select switch is the same as the neutral safety switch.

#### CLEARING DIAGNOSTIC TROUBLE CODES

1) Once all diagnostic trouble codes have been obtained, diagnostic trouble code(s) can be erased from TCM memory by disconnecting electrical connector from TCM for at least 15 seconds.

CAUTION: DO NOT disconnect battery, as data stored in other vehicle control modules will be lost.

2) The TCM is located behind right side of instrument panel on Cherokee. See Fig. 1.

## **DRB-II OPERATING MODES**

NOTE: The DRB-II can be operated in several different modes to perform various tests. Except for voltmeter/ohmmeter and HOW TO USE modes, all other operating modes are selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES.

## **VOLTMETER/OHMMETER MODE**

To access voltmeter/ohmmeter mode, connect Red volt-ohmmeter test lead to Red port at top right corner of DRB-II. There are 2 different ports on top of DRB-II; ensure test lead is connected to proper port. Access voltmeter or ohmmeter mode using manufacturer's instructions.

NOTE: The DRB-II is grounded through transmission diagnostic connector and only one test lead is required. When diagnosing transmission, an external volt-ohmmeter may sometimes be required.

## **HOW TO USE MODE**

1) This mode gives instructions on DRB-II usage. To enter this mode, see steps 1) through 4) of ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES. Select 2) HOW TO USE.

2) A series of screens will be displayed explaining DRB-II key usage for system diagnosing.

## **SYSTEM TEST MODE**

NOTE: SYSTEM TEST mode consists of a stationary test and a road test. The SYSTEM TEST mode must be selected from AW4 MENU. Refer to ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES.

1) Stationary test monitors transmission system data, current valve body solenoid failures, switch failures, correct TCM application, calibration and operation. Road test checks all valve body solenoids and speed sensor.

2) Technician will be instructed to place shift lever in each gear position, starting by shifting into 1-2 position. Once transmission is in Park, brake pedal must be depressed to check brake switch.

3) After brake switch is checked, technician will be instructed to slowly depress throttle. DRB-II will display 7 asterisks (\*\*\*\*\*) corresponding to throttle position. While depressing accelerator, Throttle Position Sensor (TPS) sweeps through entire range of positions required by the TCM.

4) A corresponding asterisk will be cleared from DRB-II display as each throttle position is sensed by TCM. Several attempts may be required to clear all asterisks from the display, depending on how fast accelerator is depressed.

5) After throttle position is checked, technician will be instructed to drive the vehicle. The DRB-II will indicate if a

requested action is seen by the TCM. If technician is requested to perform a particular operation and TCM does not acknowledge the action, press ENTER key to continue testing.

6) The TCM will instruct technician to accelerate vehicle at light throttle to ensure transmission shifts through all gears, indicating proper valve body solenoid operation.

7) During road test, ensure vehicle can be accelerated slowly and evenly to allow transmission to enter all gear ranges without downshifting or braking. If a failure is sensed, a diagnostic trouble code will be displayed on DRB-II.

**NOTE:** If TCM senses a failure, control logic activates a specified valve body solenoid to obtain a certain gear depending on failure. Because transmission diagnostic trouble codes are displayed one at a time, multiple diagnostic trouble codes must be identified by retesting transmission.

## **STATE DISPLAY MODE**

**NOTE:** STATE DISPLAY mode must be selected from AW4 MENU. See ENTERING AW4 MENU under RETRIEVING DIAGNOSTIC TROUBLE CODES. Select 3) STATE DISPLAY on DRB-II.

### **Module Information**

When selecting module information option, the TCM version will be indicated by a 2-digit number. Information can be used to verify proper TCM application.

### **Sensor**

1) When selecting sensor option, TPS and RPM indications will be shown. The TPS indicator will display a 7 segment bar graph, indicating TPS position and throttle plate angle.

2) A properly operating TPS should indicate 7 segments through full throttle travel. The RPM indicator will display transmission output shaft revolutions per minute.

### **Brake Switch Or Input/Output**

Display indicates brake switch status, indicating whether brake pedal is applied or released. Display also indicates shift lever position, whether a valve body solenoid is on or off and present transmission operating gear.

## **DRB-II PROBLEMS & ERROR MESSAGES**

### **CARTRIDGE ERROR**

1) If CARTRIDGE ERROR message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If CARTRIDGE ERROR message is displayed, replace DRB-II cartridge and proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

### **HIGH BATTERY**

If HIGH BATTERY message is displayed, use external voltmeter to check battery voltage at battery terminals. If battery voltage is 11.7-13.0 volts, replace DRB-II. If battery voltage is not 11.7-13.0 volts, check charging system.

### **KEYPAD TEST FAILURE**

1) If KEYPAD TEST FAILURE message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If KEYPAD TEST FAILURE message is not displayed, proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

## LOW BATTERY

If LOW BATTERY message is displayed, use external voltmeter to check battery voltage at battery terminals. If battery voltage is 11.7-13.0 volts, replace DRB-II. If battery voltage is not 11.7-13.0 volts, check charging system.

## RAM TEST FAILURE

1) If RAM TEST FAILURE message is displayed, disconnect DRB-II from transmission diagnostic connector. DO NOT touch keys on DRB-II keypad. Reconnect DRB-II to transmission diagnostic connector and note display.

2) If RAM TEST FAILURE message is not displayed, proceed with diagnostics. If RAM TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics. If KEYPAD TEST FAILURE message is displayed, replace DRB-II and proceed with diagnostics.

## COMPONENT TESTING

### BRAKE SWITCH TEST

Brake switch is mounted above brake pedal. When brake pedal is operated, brake switch delivers an input signal to TCM. The TCM uses input signal for controlling No. 3 valve body solenoid for torque converter lock-up. No other information is available from manufacturer.

NOTE: For proper brake switch adjustment, see BRAKE SWITCH R & I under REMOVAL & INSTALLATION.

### NEUTRAL SAFETY SWITCH TEST

NOTE: Neutral safety switch may be referred to as park/neutral or gear select switch. For proper neutral safety switch adjustment, see NEUTRAL SAFETY SWITCH R & I under REMOVAL & INSTALLATION.

Disconnect electrical connector. Note terminal identification. See Fig. 4. Using ohmmeter, check continuity between specified terminals in relation to shift lever position. See the NEUTRAL SAFETY SWITCH CONTINUITY SPECIFICATIONS table. Replace neutral safety switch if continuity is not as specified.

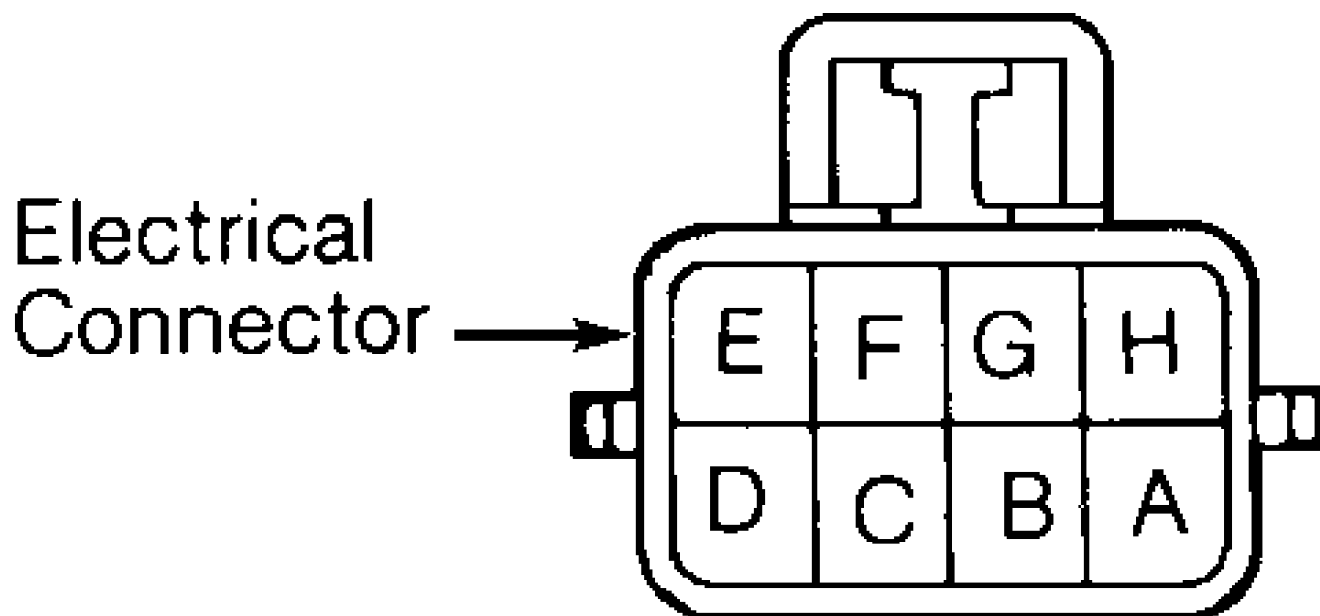
#### NEUTRAL SAFETY SWITCH CONTINUITY SPECIFICATIONS

Shift Lever Position	Continuity Between Terminals
Park .....	"B" & "C"
Reverse .....	"A" & "E"
Neutral .....	"B" & "C"
Drive .....	(1)
3 .....	"A" & "G"

1-2 ..... "A" & "H"

(1) - No continuity should exist between any terminals.

---



**92H13513**

Fig. 4: Identifying Neutral Safety Switch Terminals  
Courtesy of Chrysler Corp.

#### **SPEED SENSOR TEST**

1) Disconnect electrical connector at speed sensor located on adapter housing or extension housing. Connect ohmmeter leads between speed sensor electrical terminals.

2) Rotate transmission output shaft and note ohmmeter reading. Ohmmeter needle should fluctuate to indicate speed sensor operation. Replace speed sensor if no reading is obtained.

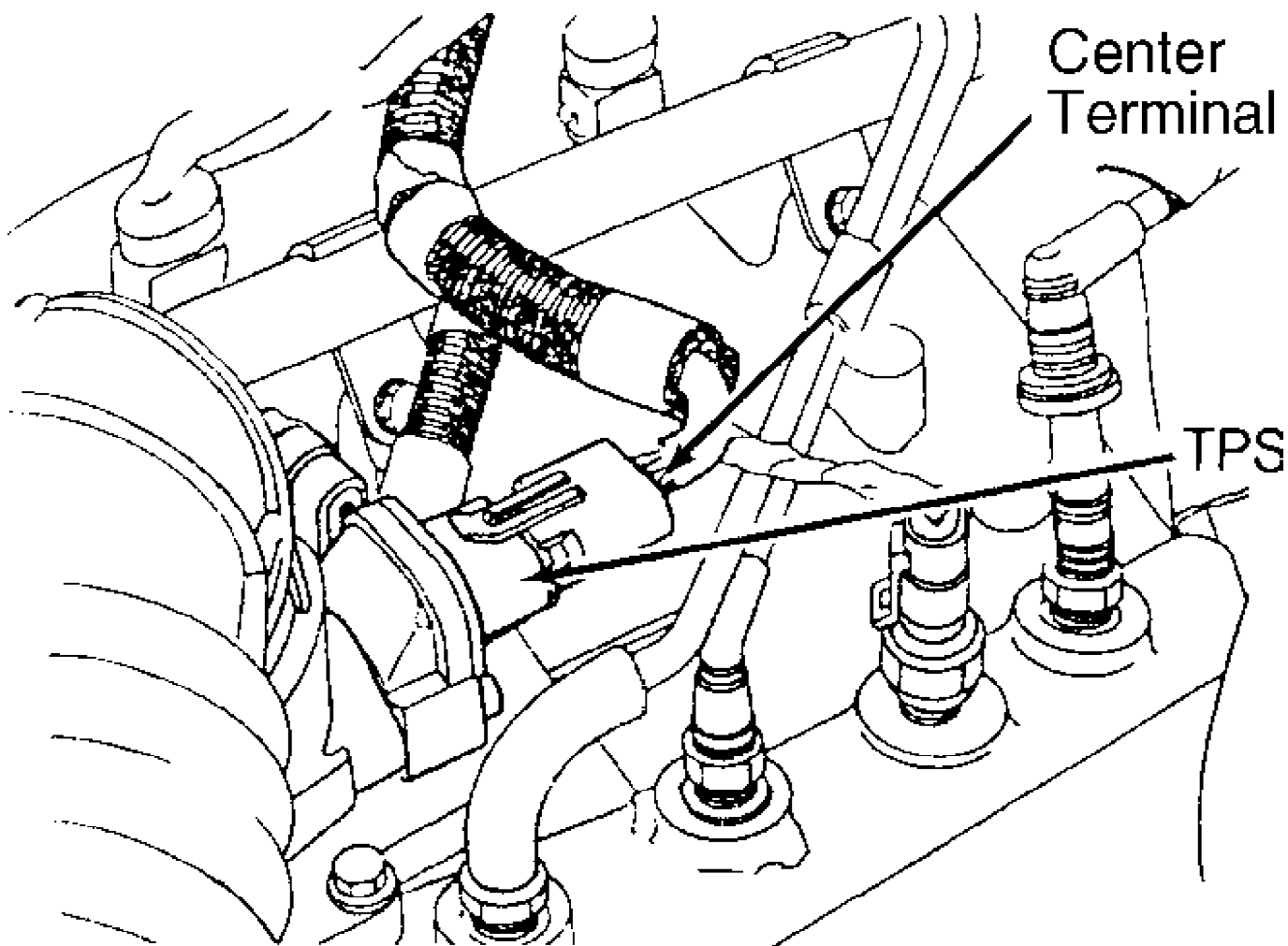
#### **THROTTLE POSITION SENSOR (TPS) TEST**

**NOTE:** Digital voltmeter must be used to check TPS.

1) Note location of TPS electrical connector. See Fig. 5. Turn ignition on. Using digital voltmeter, check output voltage at center terminal with throttle plate closed (idle position) and wide open (full throttle).

2) With throttle plate closed (idle position), output voltage should be greater than 200 millivolts. With throttle plate wide open (full throttle), output voltage should be less than 4.8 volts.

3) Ensure output voltage gradually increases as throttle plate is moved from closed to wide open throttle. If no voltage exists, check for defective wiring circuits or connections. Replace TPS if defective.



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Fig. 5: Identifying TPS Electrical Connector  
Courtesy of Chrysler Corp.

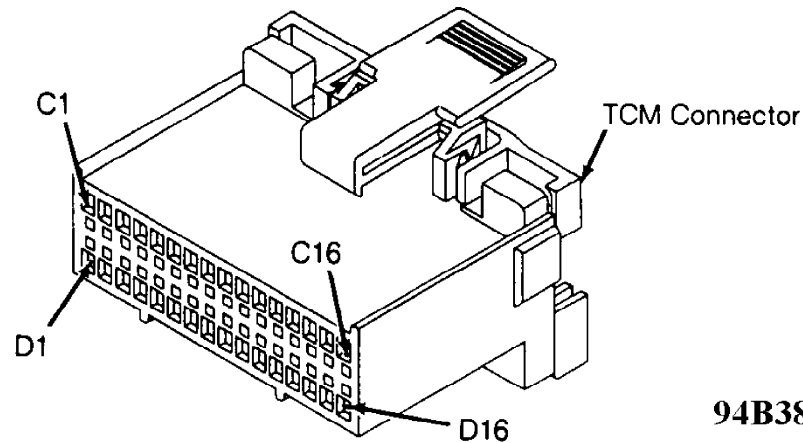
#### VALVE BODY SOLENOID TEST

With oil pan removed, disconnect electrical connector from valve body solenoid. Using ohmmeter, check resistance between valve body solenoid electrical terminal and solenoid mounting bracket. Replace valve body solenoid if resistance is not 11-15 ohms.

#### TROUBLE SHOOTING CHARTS & CODE CHARTS

**NOTE:** Following trouble shooting charts and illustrations are courtesy of Chrysler Corp. Always start by performing TEST 1A - VERIFICATION OF COMPLAINT. When diagnosing transmission, it may be necessary to verify TCM connector terminals, circuits and function, See Fig. 6.

**NOTE:** When using trouble shooting charts, Transmission Control Module (TCM) may be referred to as Transmission Control Unit (TCU). Diagnostic trouble code may be referred to as fault code. Neutral safety switch may be referred to as park/neutral or gear select switch.



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#### CHEROKEE

CAV ... CIRCUIT .....	FUNCTION
C1-C2 .....	Not Used
C3 ..... 505 TN/BK .....	Trans Speed Sensor
C4 ..... 137 YL/BK .....	Auto Trans Diagnostic
C5-C7 .....	Not Used
C8 ..... 506 LG/BK .....	Low (1-2) Input
C9 ..... 507 GY/BK .....	Drive (3) Input
C10 ..... K29 WT/PK .....	Brake Input
C11 .....	Not Used
C12-C13 .....	Not Used
C14 ..... 508 WT/BK .....	S3 Solenoid (Converter Lockup)
C15 ..... 509 VT/WT .....	S2 Solenoid
C16 ..... 510 DB/WT .....	S1 Solenoid
D1 .....	Not Used
D2 ..... K22 OR/DB .....	Throttle Position Sensor
D3 ..... K4 BK/LB .....	TPS Signal Ground
D4-D6 .....	Not Used
D7 ..... Z12 BK/TN .....	Power Ground
D8-D13 .....	Not Used
D14 ..... A14 RD .....	Battery
D15 .....	Not Used
D16 ..... T17 YL .....	Ignition (Run/On)

#### GRAND CHEROKEE

CAV... CIRCUIT .....	FUNCTION
C1-C2 .....	Not Used
C3 ..... T14 LG/WT .....	Trans Speed Sensor
C4 ..... D82 BK/YL .....	Auto Trans Diagnostic
C5-C7 .....	Not Used
C8 ..... T25 LG .....	Low (1-2) Input
C9 ..... T50 DG .....	Drive (3) Input
C10 .... L53 BR .....	Brake Input
C11-C13 .....	Not Used
C14 .... T20 LB/BR .....	S3 Solenoid (Converter Lockup)
C15 .... T59 PK .....	S2 Solenoid
C16 .... T60 BR/YL .....	S1 Solenoid
D1 .....	Not Used
D2 ..... K22 OR/DB .....	Throttle Position Sensor
D3 ..... K4 BK/LB .....	TPS Signal Ground
D4-D6 .....	Not Used
D7 ..... Z1 BK .....	Power Ground
D8-D13 .....	Not Used
D14 .... A14 RD/WT .....	Battery
D15 .....	Not Used
D16 .... F86 LB/RD .....	Ignition (Run/On)

Fig. 6: TCM Connector Terminals I.D., Circuits & Functions  
Courtesy of Chrysler Corp.

#### TEST 1A - VERIFICATION OF COMPLAINT

NOTE: ALWAYS start diagnosis with the most recent code.

- 1) Begin your testing of the transmission with a thorough visual inspection.
- 2) Connect the DRB-II to the transmission diagnostic



connector. See RETRIEVING DIAGNOSTIC TROUBLE CODES under SELF-DIAGNOSTIC SYSTEM for diagnostic connector location.

**CAUTION:** If the vehicle is in 3rd or OD position and feels like it is stuck in 3rd or jumping from 2-1 or 3-1, perform TEST 10A - TESTING FOR INTERMITTENT SPEED SENSORS.

3) With the DRB-II, perform SYSTEM TEST. See SYSTEM TEST MODE under DRB-II OPERATING MODES.

4) The DRB-II will instruct you to do some actions during the System Test. The DRB-II will then look for the action to happen and automatically go to the next test function. If you perform the required action and the DRB-II does not move to the next function, press ENTER. The DRB-II will continue the testing.

5) When the DRB-II states "VEHICLE DRIVE", the vehicle must be driven at a speed above 4 miles per hour to ensure accurate testing of the vehicle speed sensor. Afterwards, the DRB-II will display any fault codes that may be present.

6) When the system test is complete, if there are any fault codes present, the DRB-II will automatically display the code(s).

7) There are two types of faults for the transmission solenoids. They are displayed as "FAULT STORED" and "FAULT PRESENT". Note that the tests are different in the chart below.

8) Perform the tests shown below in response to the indicated fault codes.

**NOTE:** ALWAYS start diagnosis with the most recent code.

## CODE-TO-TEST MENU

### CODE-TO-TEST MENU

Code:	Solenoid Affected:	Fault Status:	Perform:
None	None Affected	No Faults	TEST 2A
700	Solenoid No. 1	Fault Present	TEST 4A
700	Solenoid No. 1	Fault Stored	TEST 3A
700	Solenoid No. 2	Fault Present	TEST 4B
700	Solenoid No. 2	Fault Stored	TEST 3A
700	Solenoid No. 3	Fault Present	TEST 4C
700	Solenoid No. 3	Fault Stored	TEST 3A
702	Speed Sensor Fault	"	TEST 5A
703	Gear Select Fault	"	TEST 6A
705	TPS Fault	"	TEST 7A
708	Wrong TCU	"	TEST 9A

## TEST 2A - VERIFICATION TEST

**NOTE:** Perform TEST 1A - VERIFICATION OF COMPLAINT before proceeding.

This test verifies the correct operation of the AW4

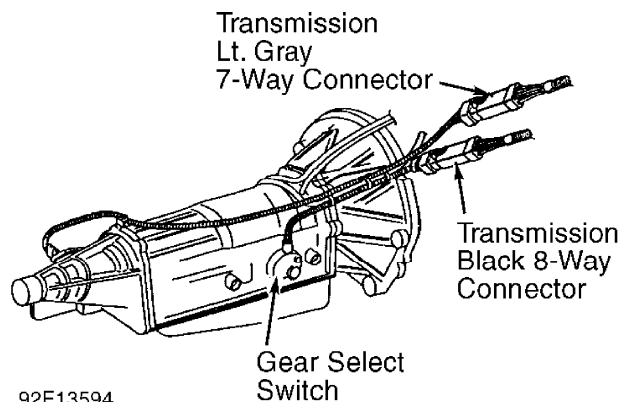
transmission. It must be performed after finding no faults using the DRB-II, and after a vehicle repair has been made.

- 1) Turn ignition key to "OFF".
- 2) Hold the MODE key and press the ATM key on the DRB-II at the same time to restart the DRB-II.
- 3) Turn ignition key to "ON".
- 4) Reconnect all previously disconnected connectors.
- 5) Verify that the AW4 transmission control unit is properly mounted.
- 6) Make sure the transmission fluid is at the proper level. Check the fluid with the transmission temperature hot, the vehicle on level ground, and the gear selector in neutral.
- 7) If any repairs have been made, test the vehicle as instructed in TEST 1A - VERIFICATION OF COMPLAINT., and read the faults using the DRB-II. If there are any fault messages present, repeat TEST 1A - VERIFICATION OF COMPLAINT.

### TEST 3A - STORED DIAGNOSTIC TROUBLE CODES TEST

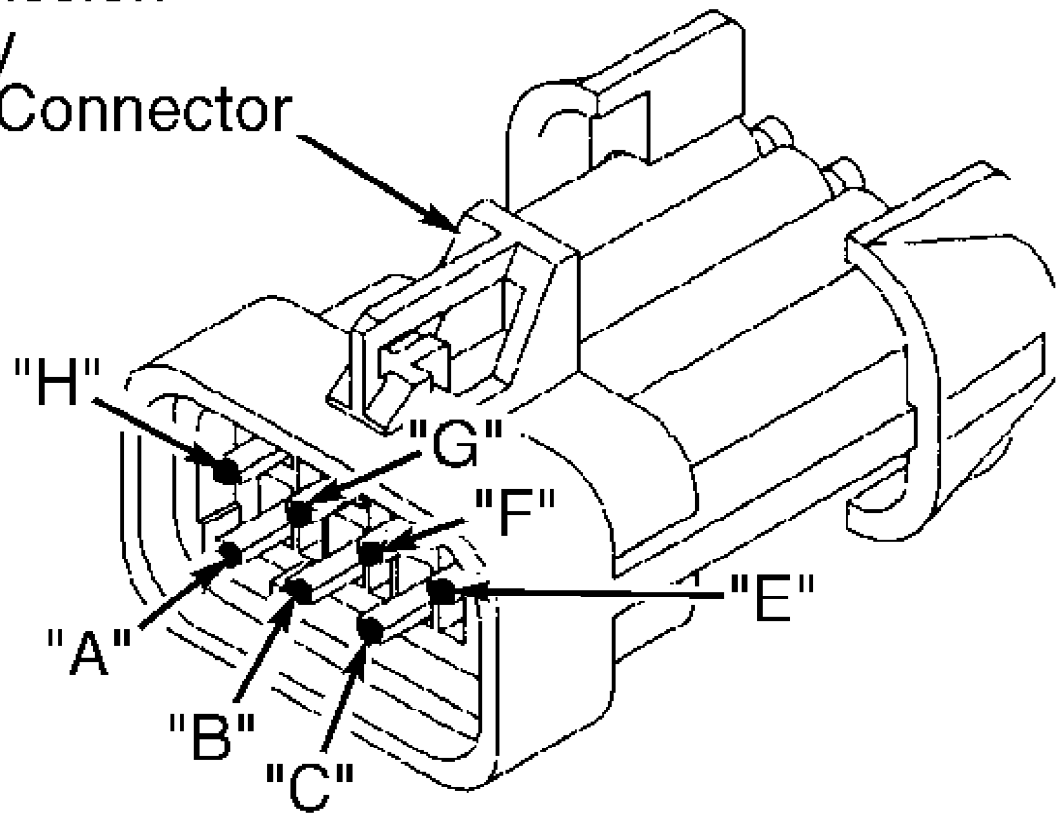
NOTE: Perform TEST 1A - VERIFICATION OF COMPLAINT before proceeding.

- 1) At this point, the Visual Inspection has been performed, a "FAULT STORED" code has been found and the vehicle has been test driven. The fault code is not "FAULT PRESENT", so it cannot be considered a CURRENT or HARD fault.
- 2) All solenoid circuits are in the same harness and a common ground wire is used for the solenoids. Use the following figures to identify the harness and connector to inspect. See Fig. 7 and 8. if all 3 solenoid faults are present, repair the Black wire (Cherokee) ground wire open condition.
- 3) Carefully inspect the entire suspected circuit. Pay particular attention to connectors, corrosion, accident damage, and improper or missing parts.
- 4) If any problems are found, make the appropriate repair. Then perform TEST 1A using the DRB-II.
- 5) Erase fault codes.
- 6) If no problems are found, perform the SYSTEM TEST using the DRB-II. Re-check for fault codes. If there are no fault codes, perform TEST 2A - VERIFICATION TEST. If fault code(s) return, perform TEST 1A - VERIFICATION OF COMPLAINT.



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Fig. 7: Test 3A - Location of 7-Way Connector

# Transmission Lt. Gray 7-Way Connector



A	B	C	E	F	G	H
BK/YL	BK/TN	TN/WT	WT/BK	VT/WT	DB/WT	BK/RD

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Fig. 8: Test 3A - View of 7-Way Connector (Cherokee)

TEST 4A - CODE 700 - S1 SOLENOID CIRCUIT

Perform TEST 1A before proceeding.

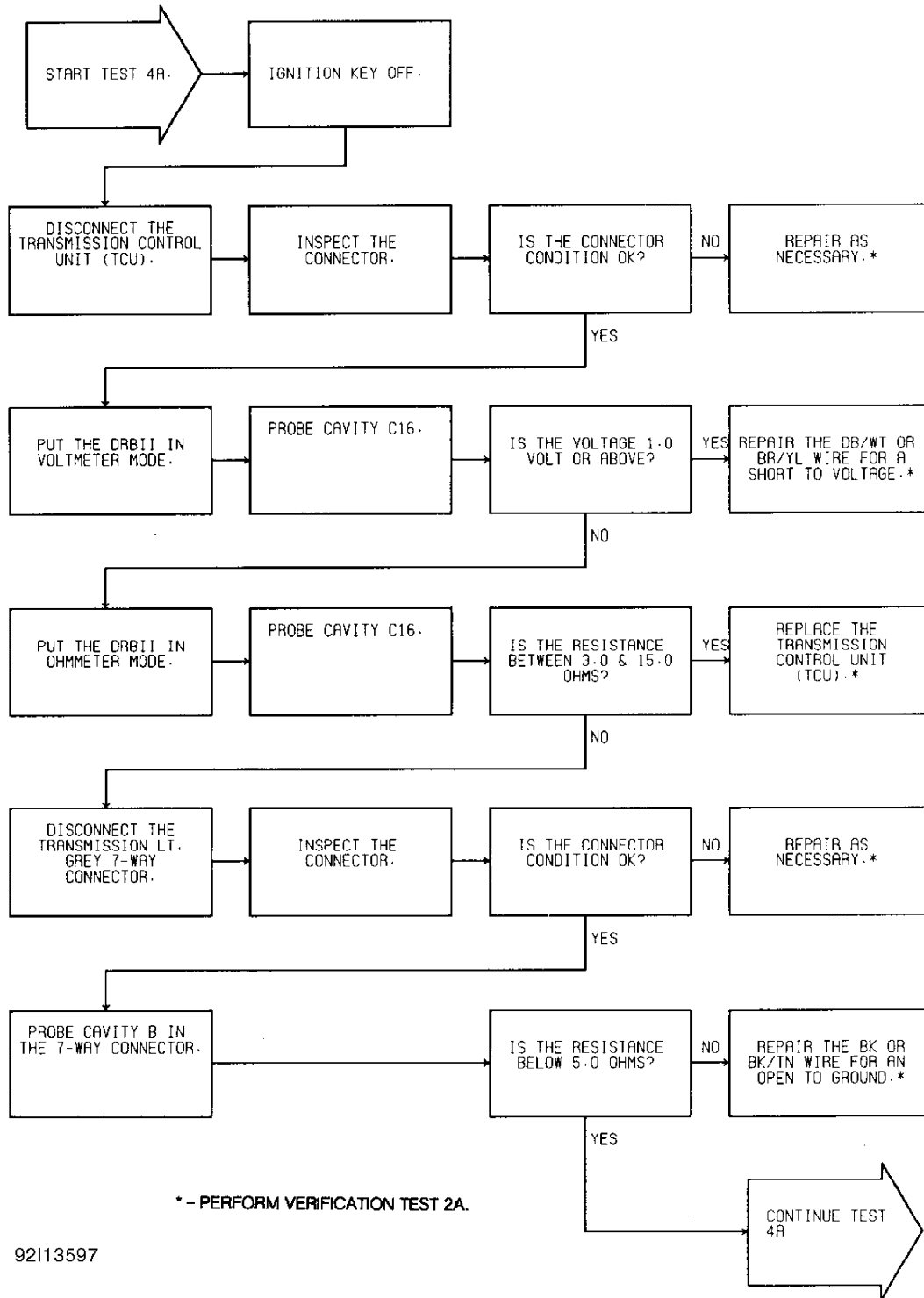
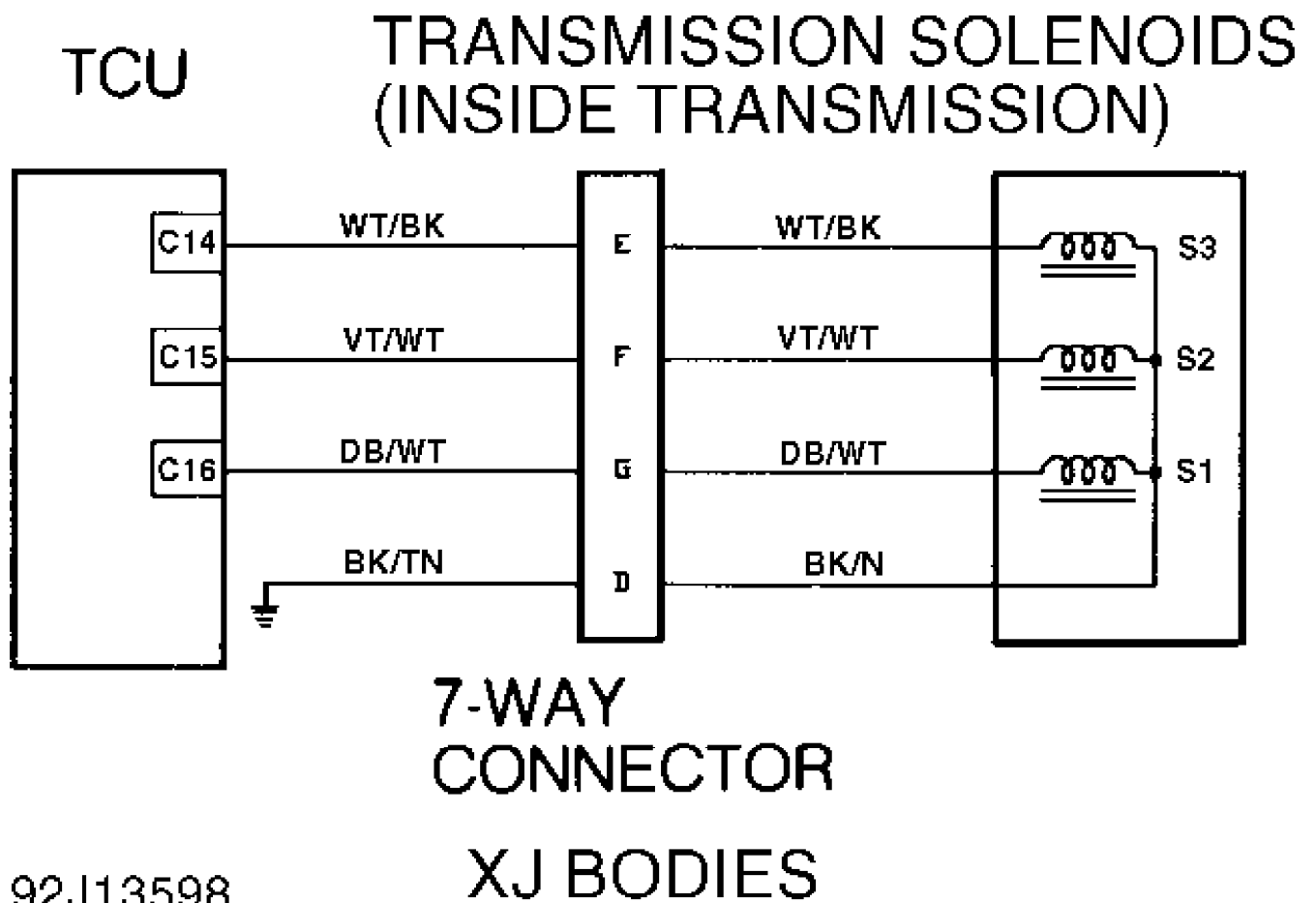
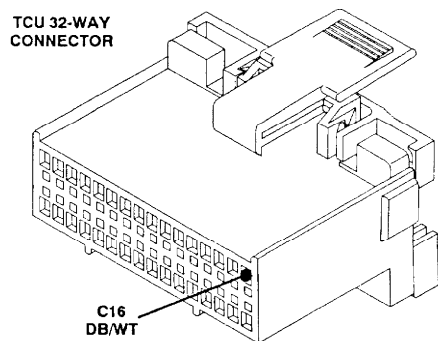


Fig. 9: Test 4A - Code 700, Flow Chart (1 of 2)



92J13598  
Fig. 10: Test 4A - Code 700, Schematic (Cherokee)



92D13600  
ZJ Body: BR/YL  
Fig. 11: Test 4A - Code 700, TCU 32-Way Connector (Cavity 16)

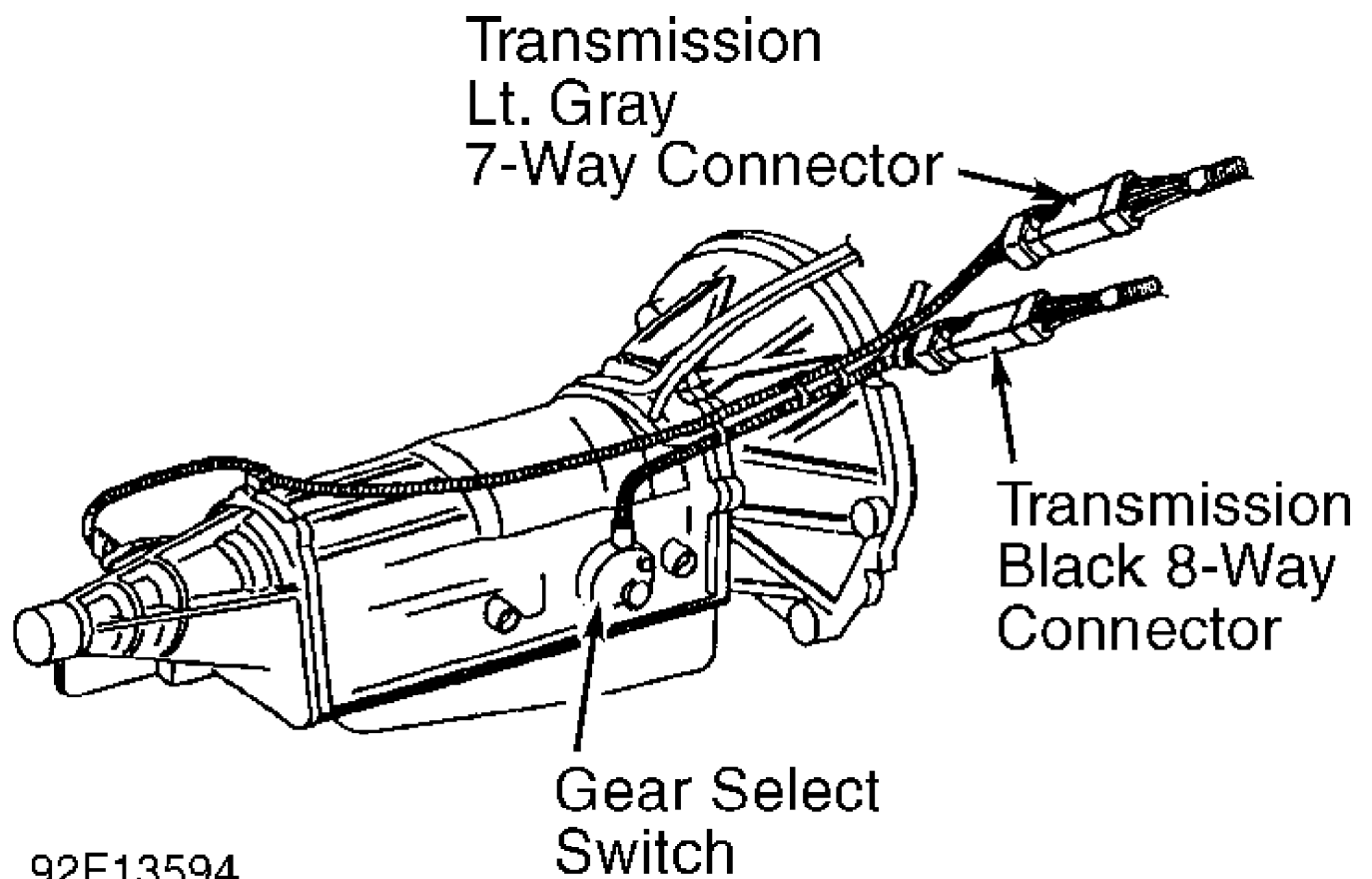


Fig. 12: Test 4A - Code 700, Location of 7-Way Connector

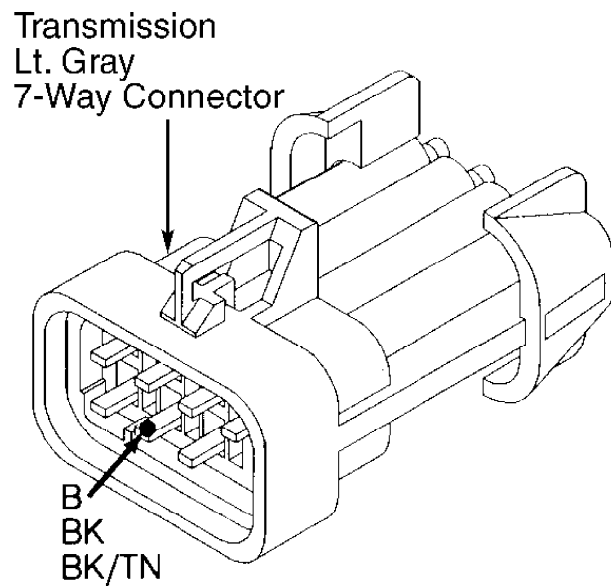
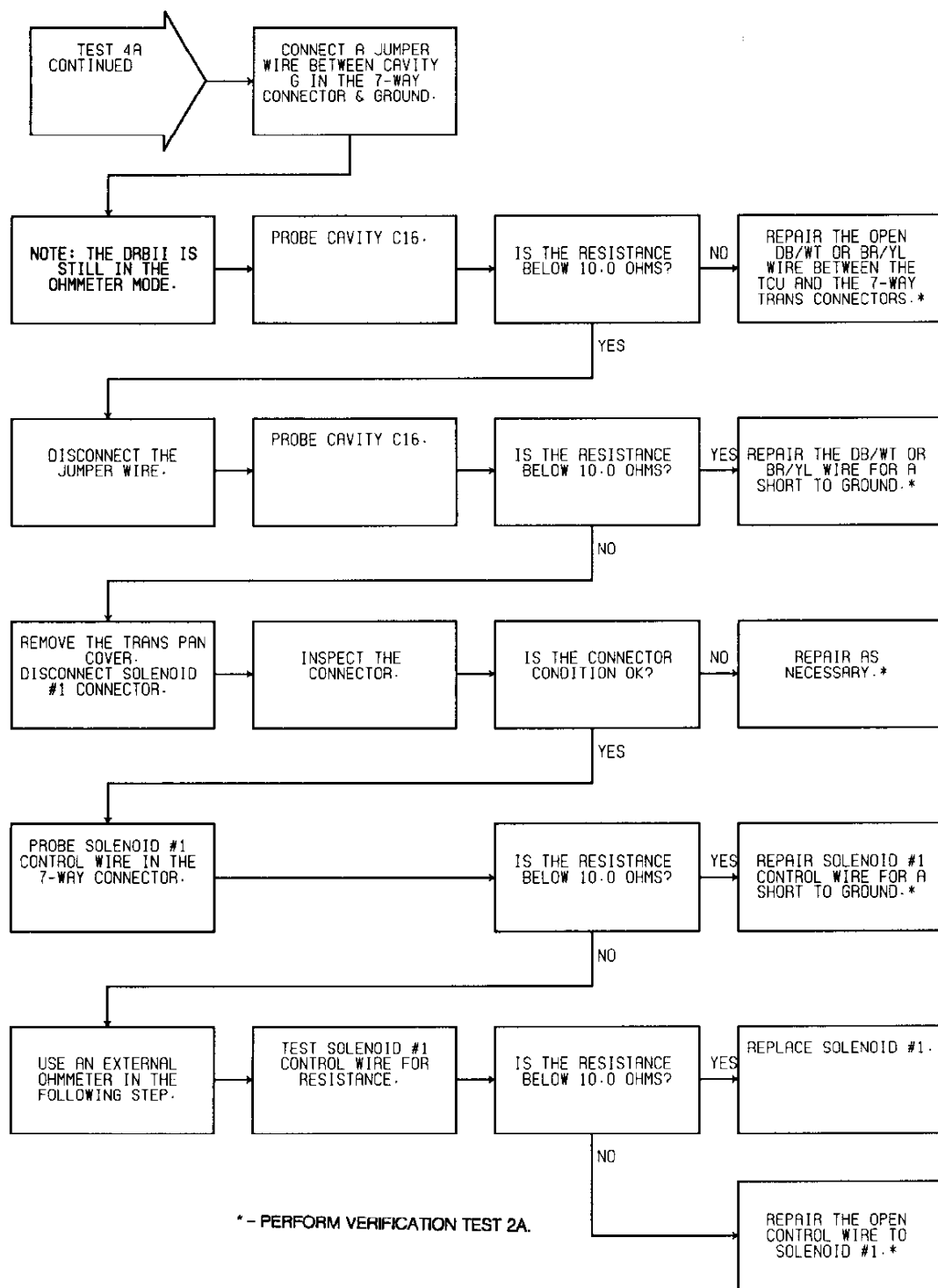


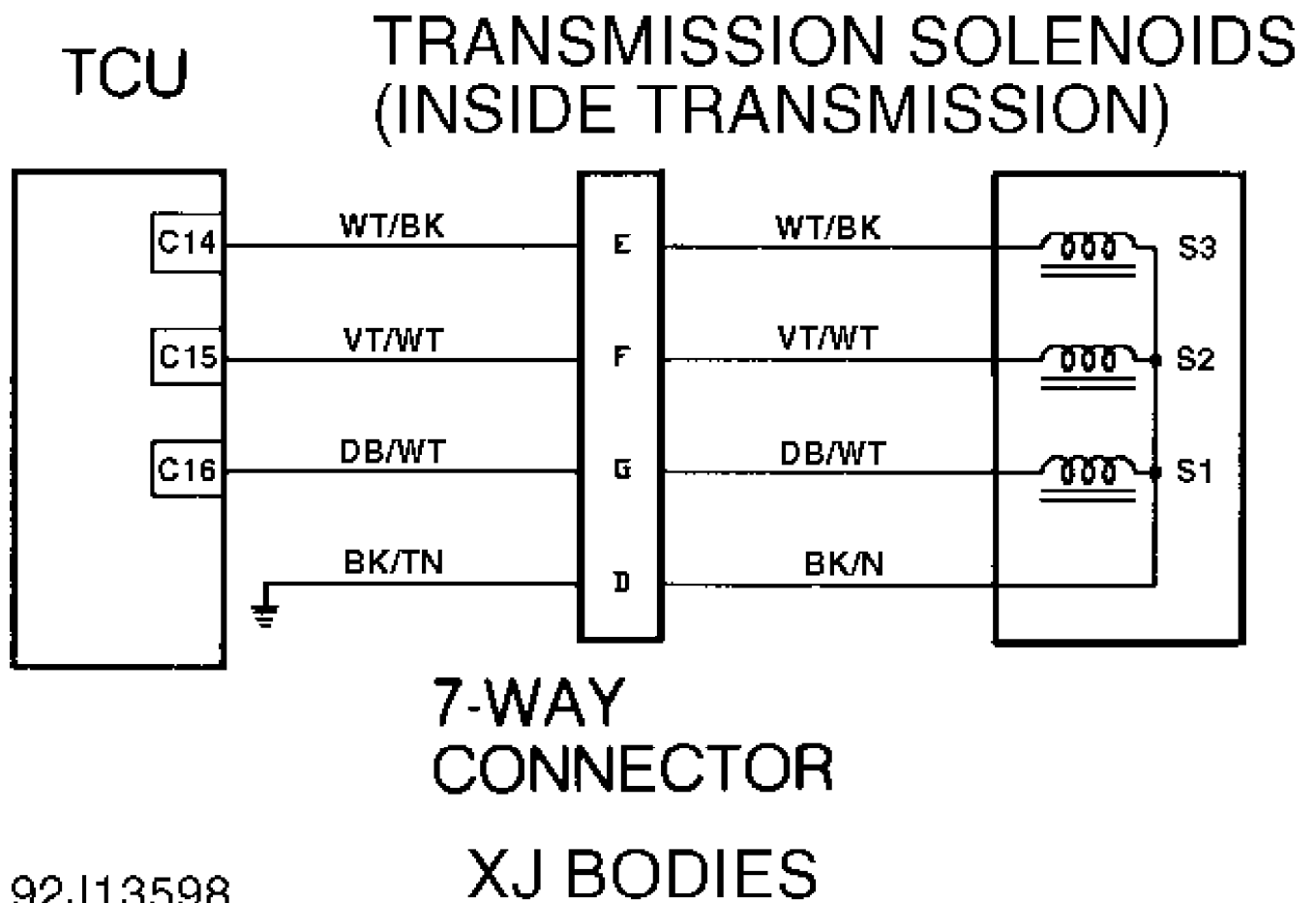
Fig. 13: Test 4A - Code 700, Location of Pin "B" (Ground)



**NOTE: See TEST 4A (1 OF 2) for wiring diagram.**

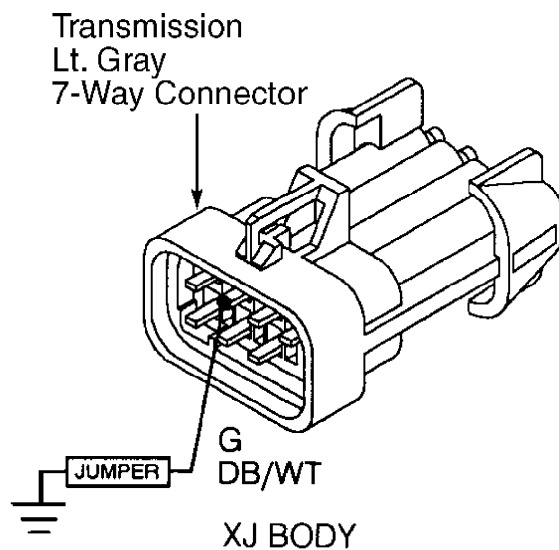
92F13602

Fig. 14: Test 4A - Code 700, Flow Chart (2 of 2)



92J13598

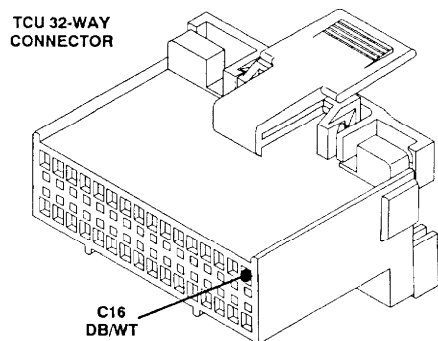
Fig. 15: Test 4A - Code 700, Schematic (Cherokee)



92G13603

Fig. 16: Test 4A - 7-Way Connector Cavity "G" (Cherokee)





92D13600

ZJ Body: BR/YL

Fig. 17: Test 4A - Code 700, TCU 32-Way Connector (Cavity 16)

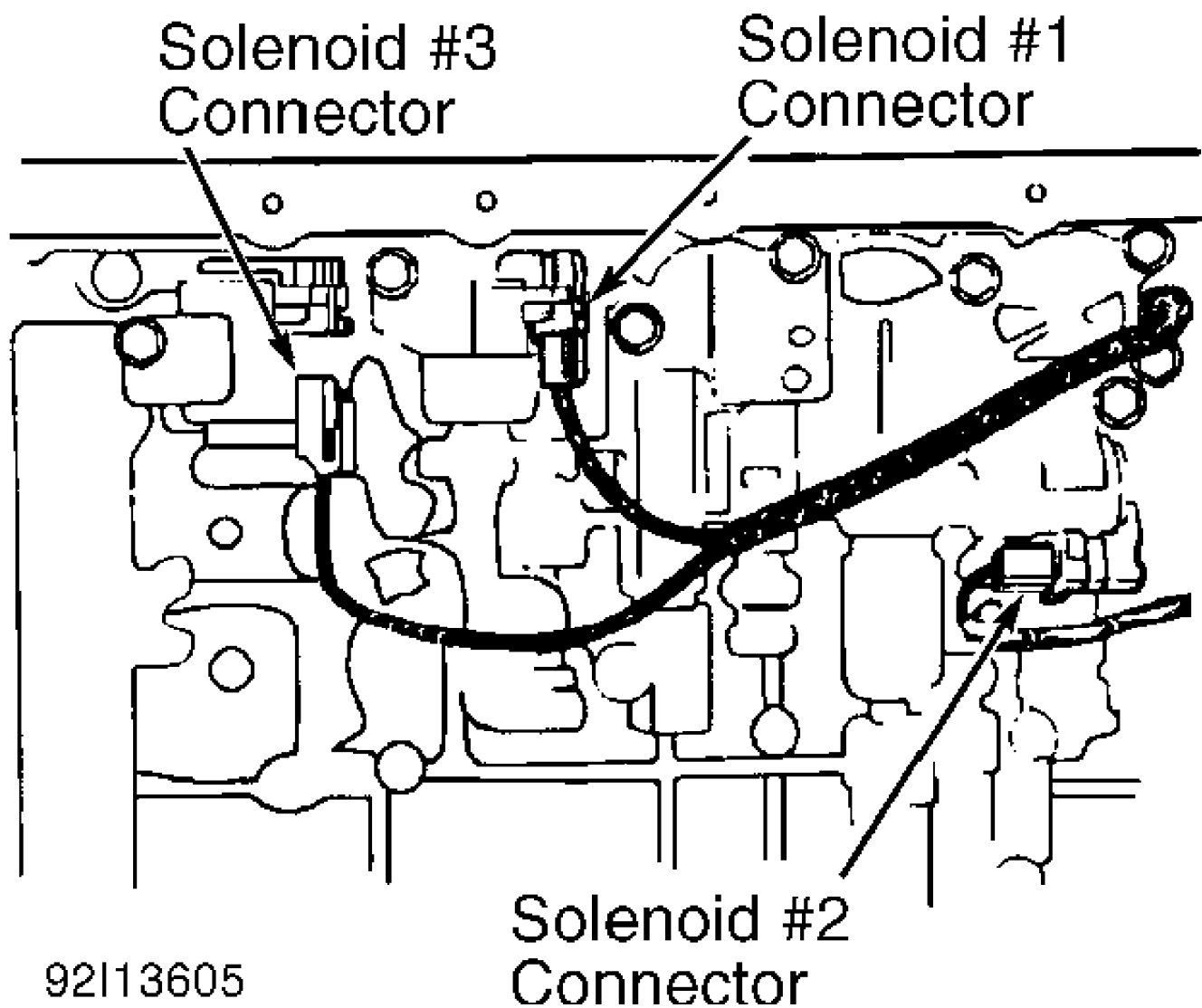
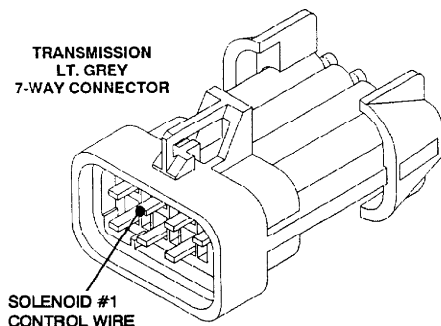


Fig. 18: Test 4A - Code 700, Location of Solenoids



CAV	MJ/XJ	ZJ
G	DB/WT	BR/YL

Fig. 19: Test 4A - Code 700, Solenoid No. 1 Wire (Cavity "G")<sup>92J13606</sup>

Transmission  
Lt. Gray  
7-Way Connector →

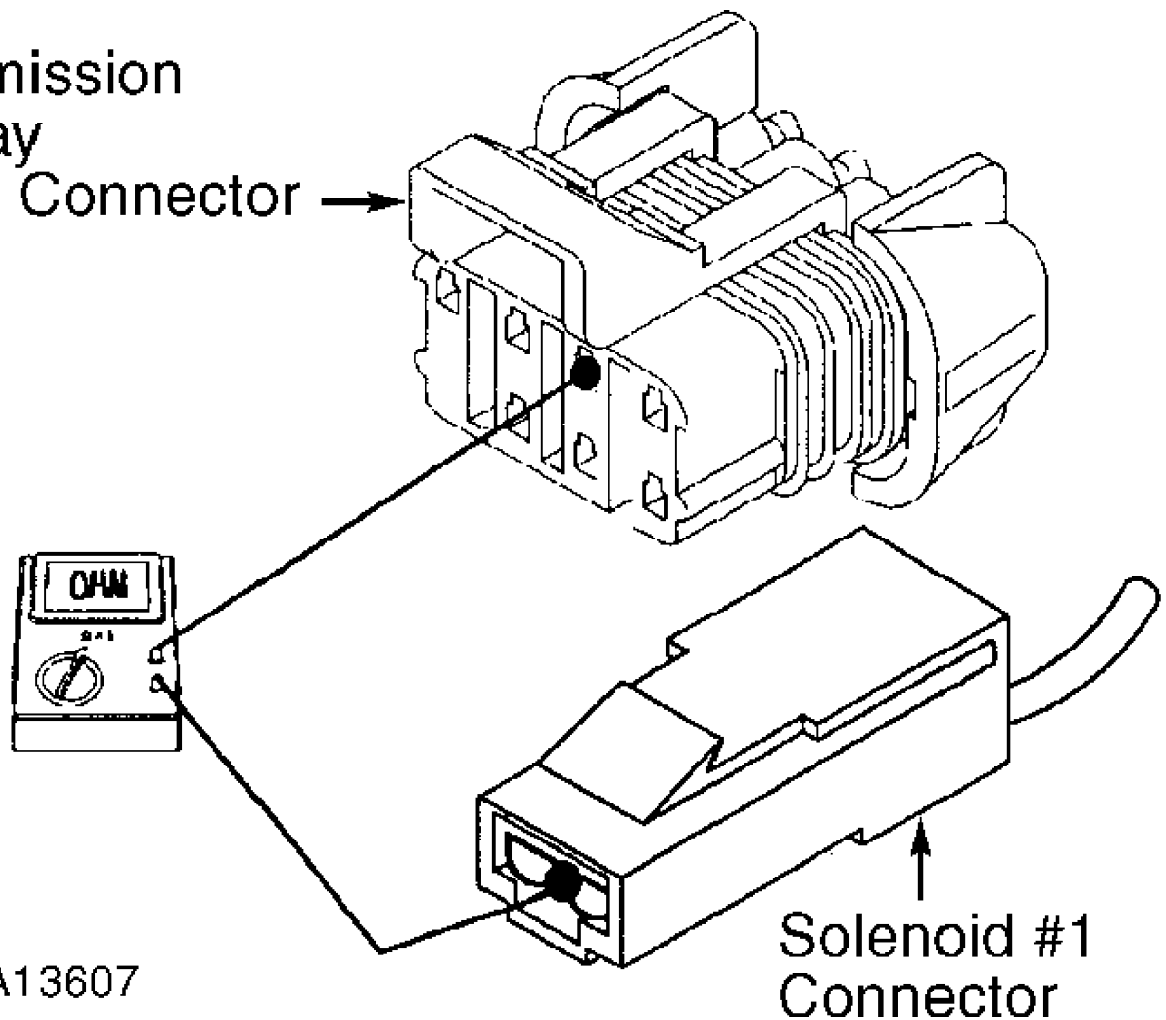


Fig. 20: Test 4A - Code 700, Testing S1 Control Wire

TEST 4B - CODE 700 - S2 SOLENOID CIRCUIT

Perform TEST 4A before proceeding.

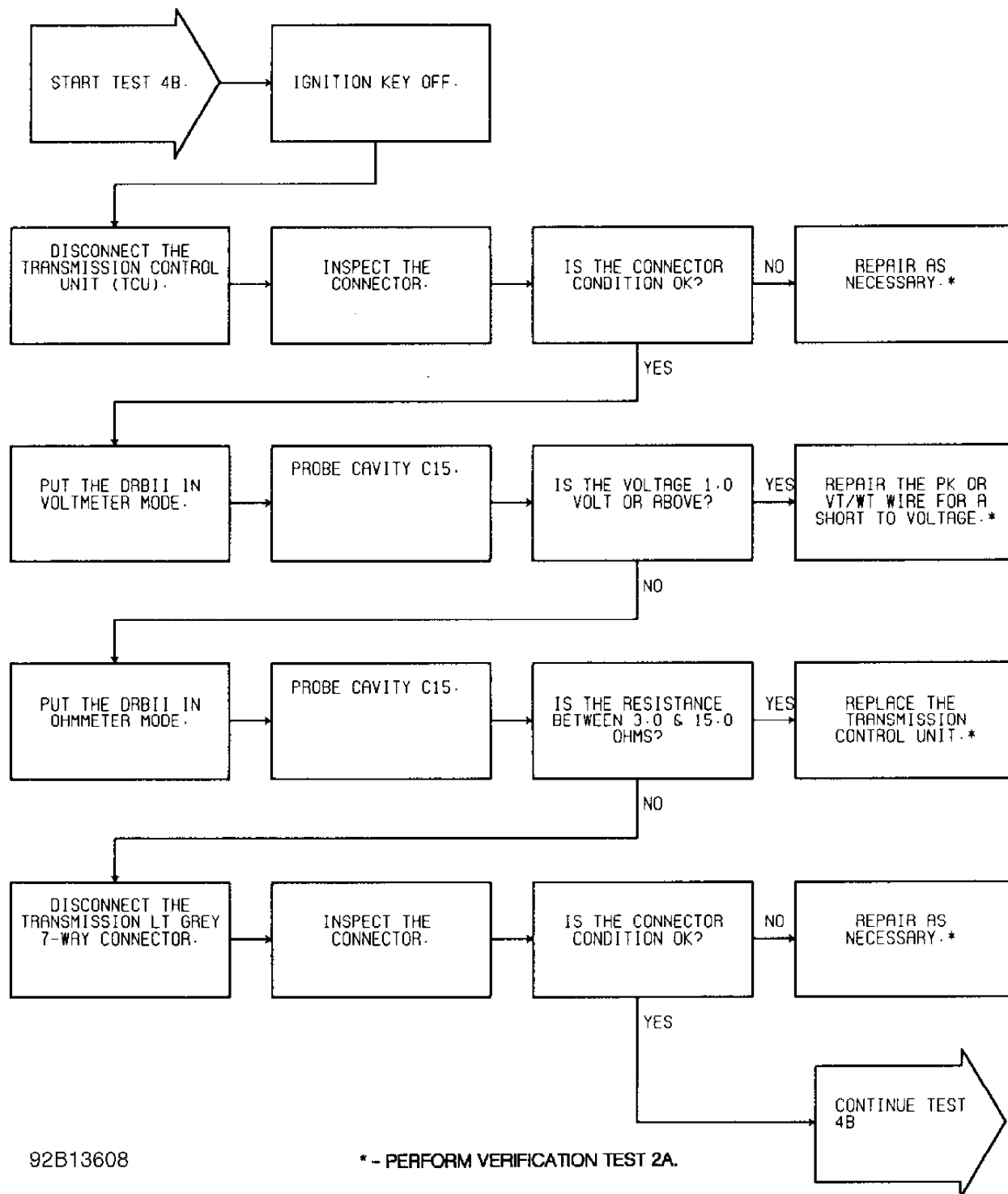
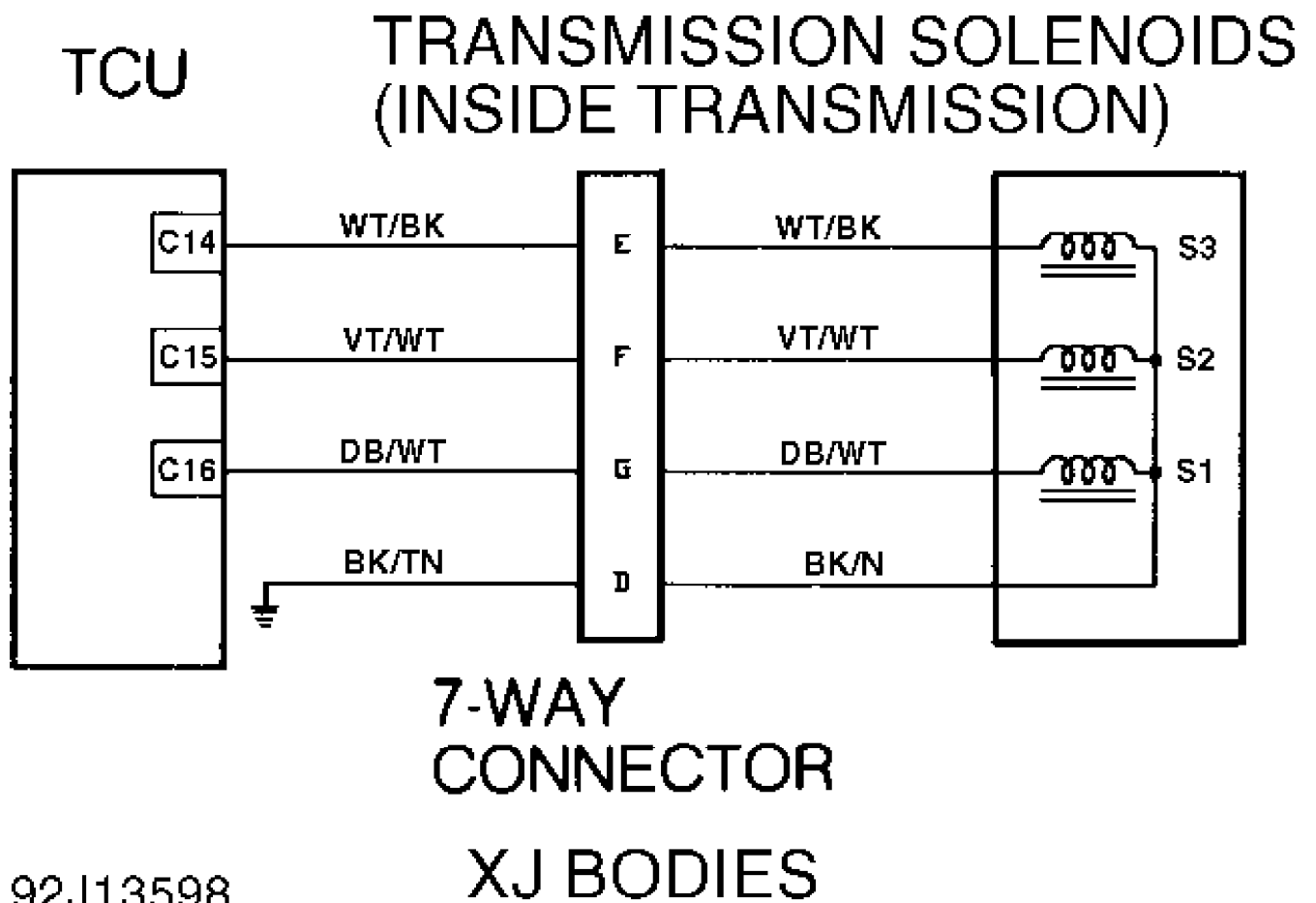
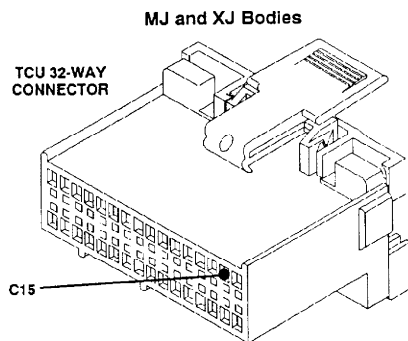


Fig. 21: Test 4B - Code 700, Flow Chart (1 of 2)



92J13598

Fig. 22: Test 4B - Code 700, Schematic (Cherokee)



CAV	MJ/XJ	ZJ
C15	VT/WT	PK

92C13609

Fig. 23: Test 4B - Code 700, TCU 32-Way Connector (Cavity 15)

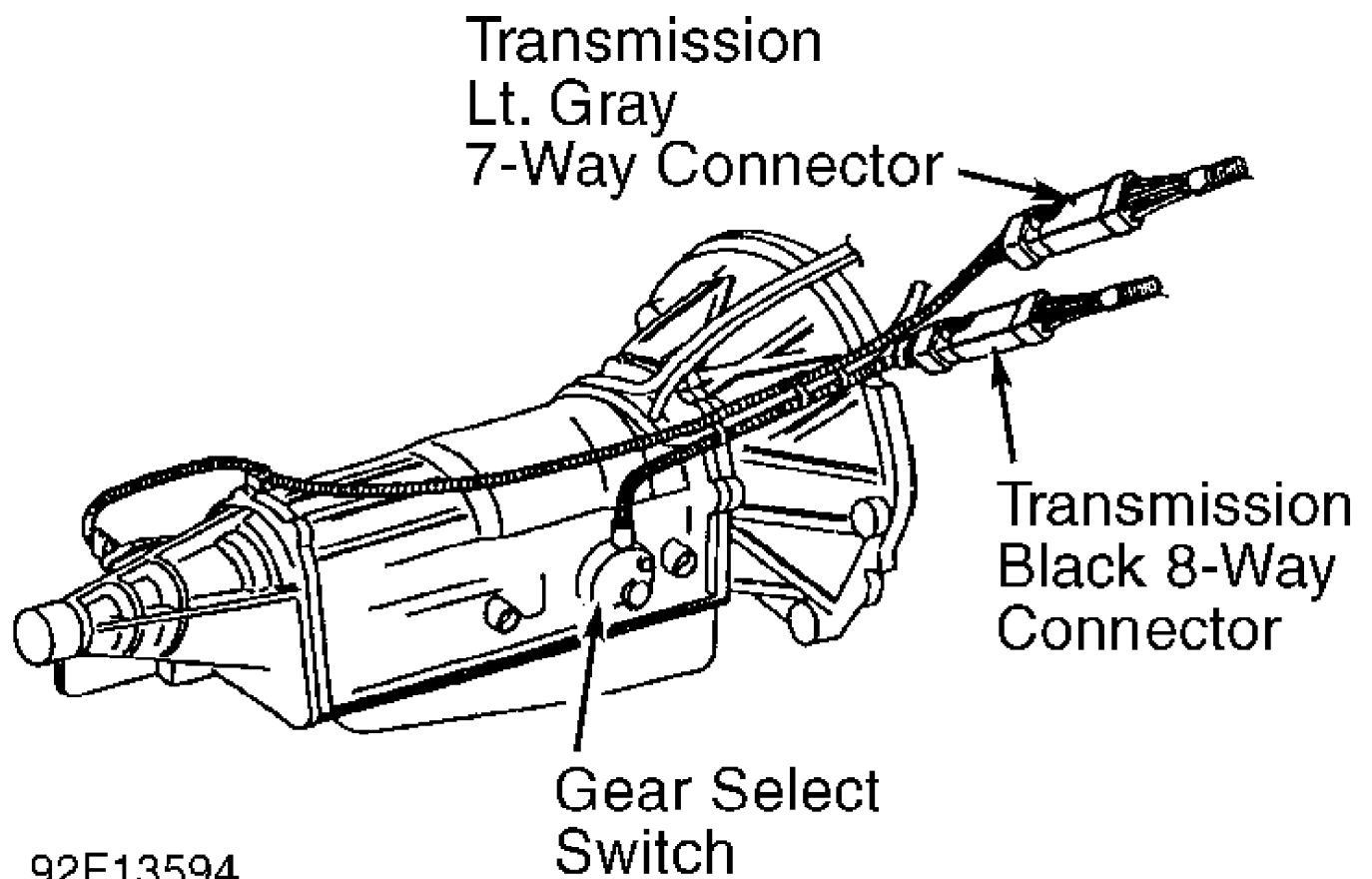
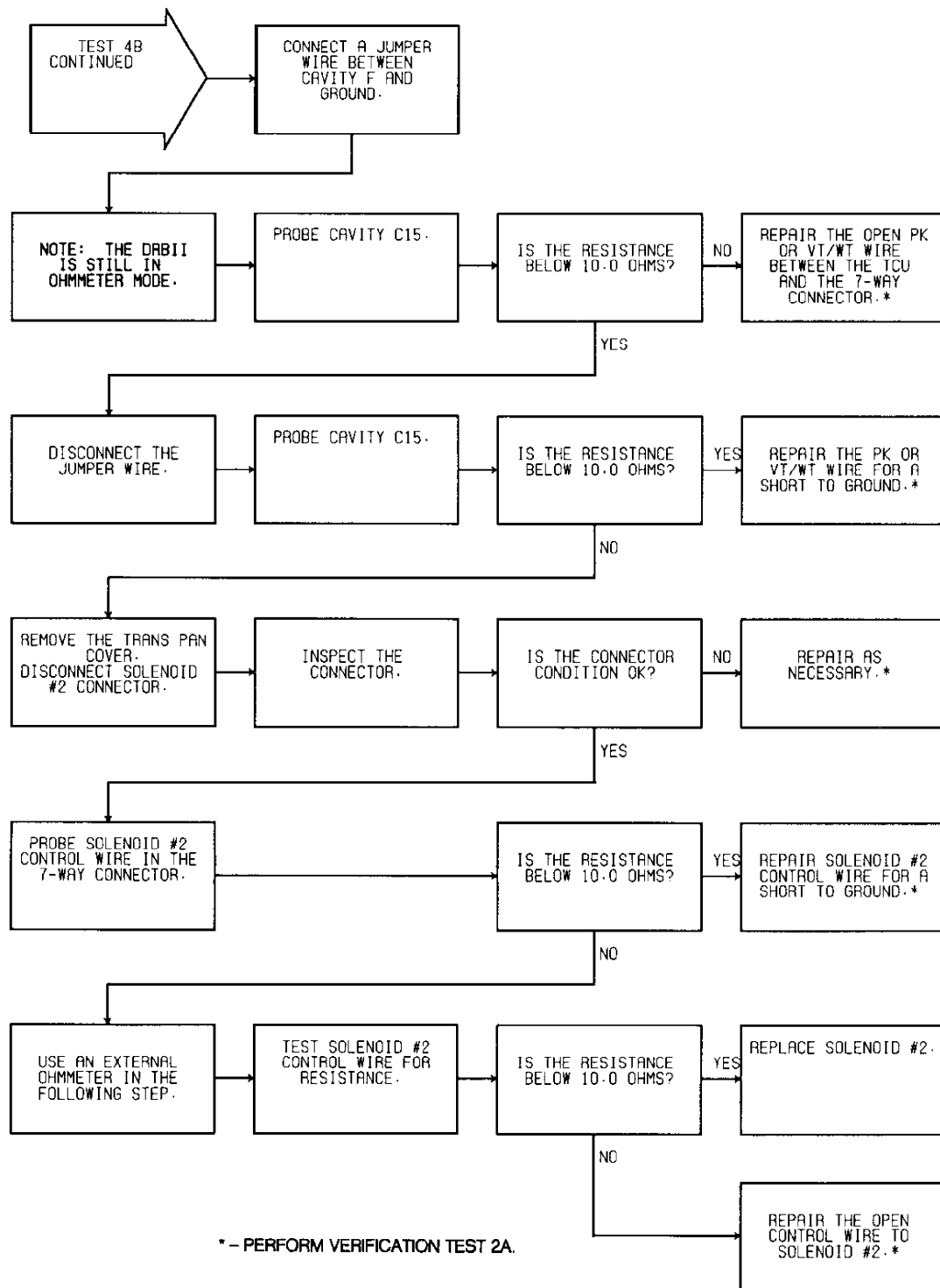


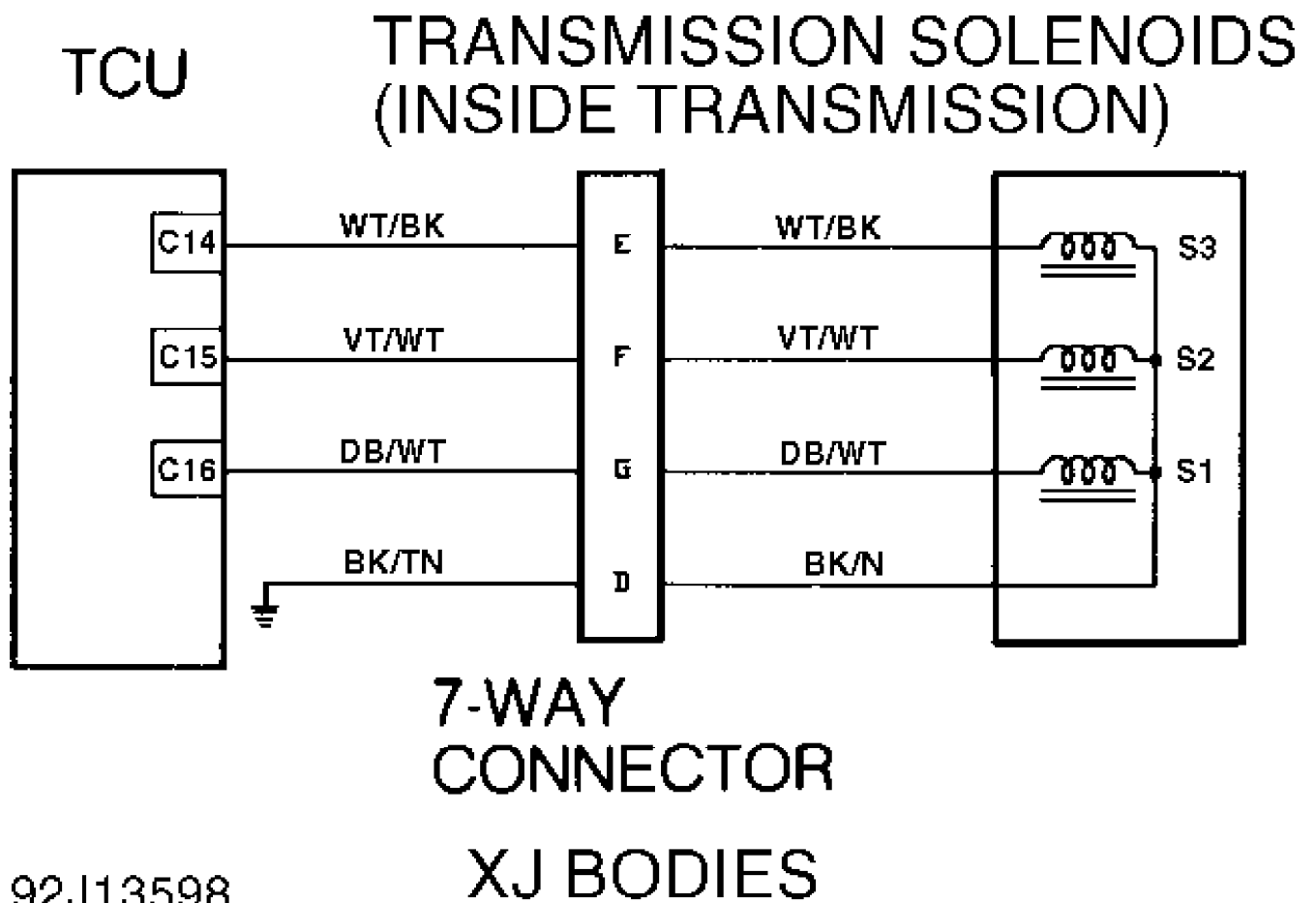
Fig. 24: Test 4B - Code 700, Location of 7-Way Connector



**NOTE: See TEST 4B (1 OF 2) for wiring diagram.**

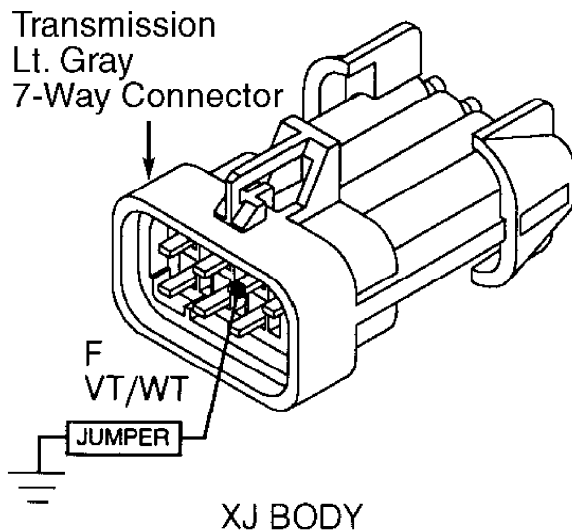
92F13610

Fig. 25: Test 4B - Code 700, Flow Chart (2 of 2)



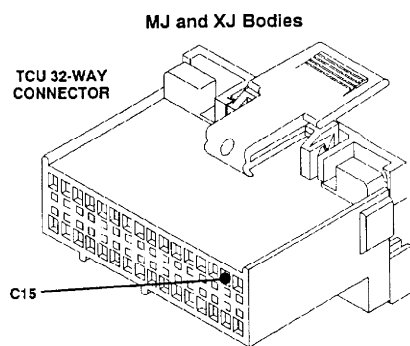
92J13598

Fig. 26: Test 4B - Code 700, Schematic (Cherokee)



92G13611

Fig. 27: Test 4B - 7-Way Connector Cavity "F" (Cherokee)



CAV	MJ/XJ	ZJ
C15	VT/WT	PK

92C13609

Fig. 28: Test 4B - Code 700, TCU 32-Way Connector (Cavity 15)

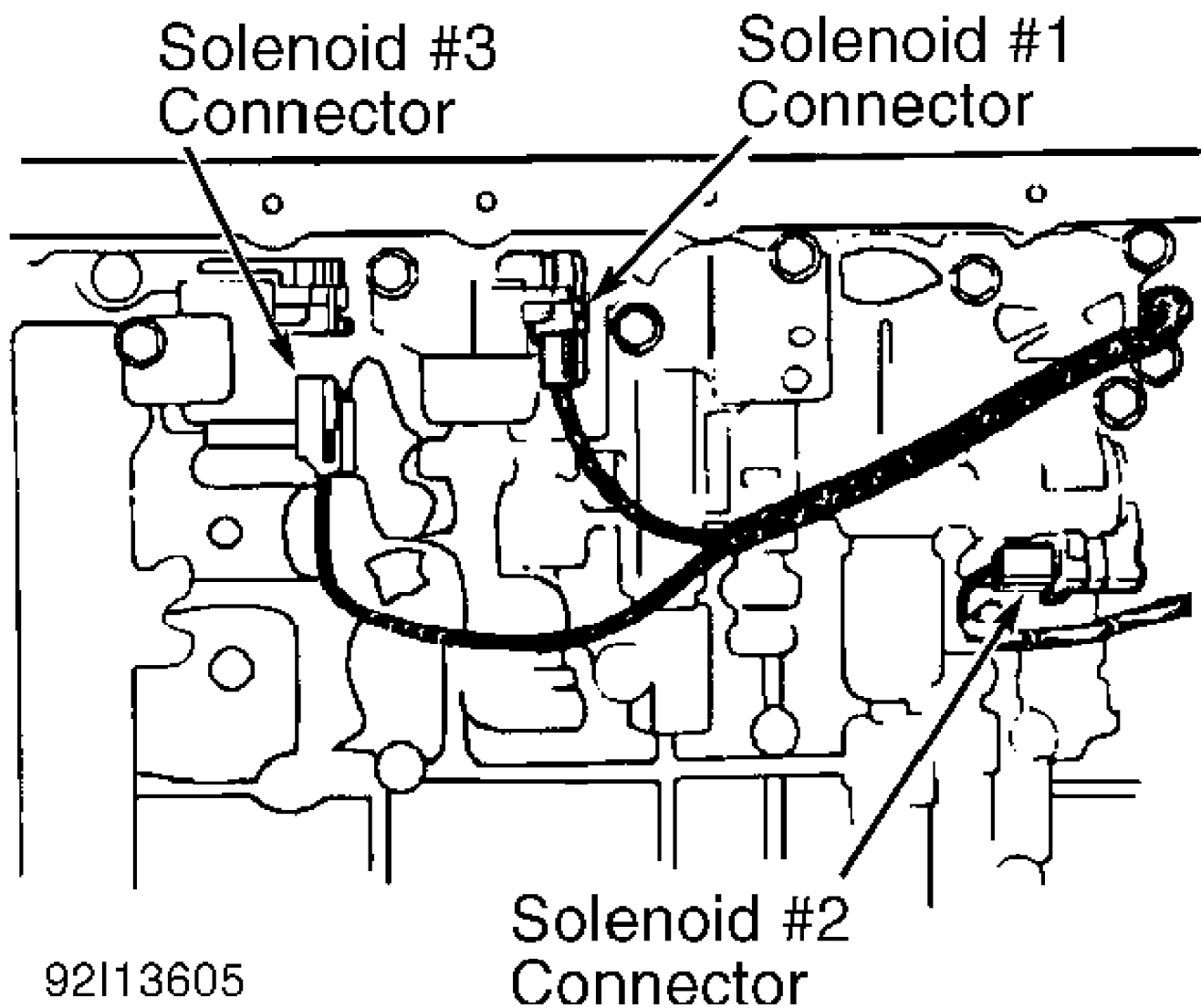
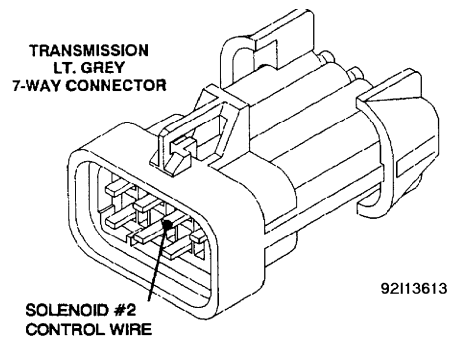


Fig. 29: Test 4B - Code 700, Location of Solenoids





CAV	MJ/XJ	ZJ
F	VT/WT	PK

Fig. 30: Test 4B - Code 700, Solenoid No. 1 Wire (Cavity "F")

Transmission  
Lt. Gray  
7-Way Connector

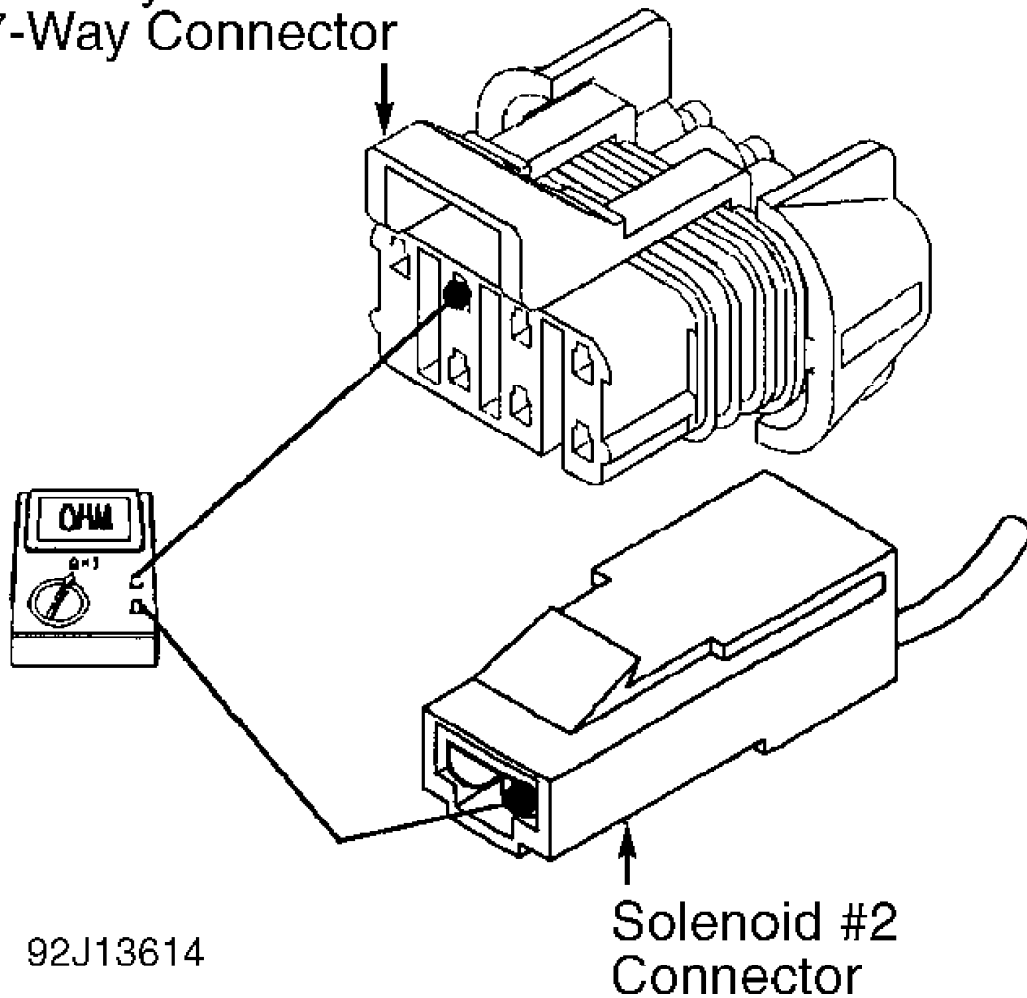
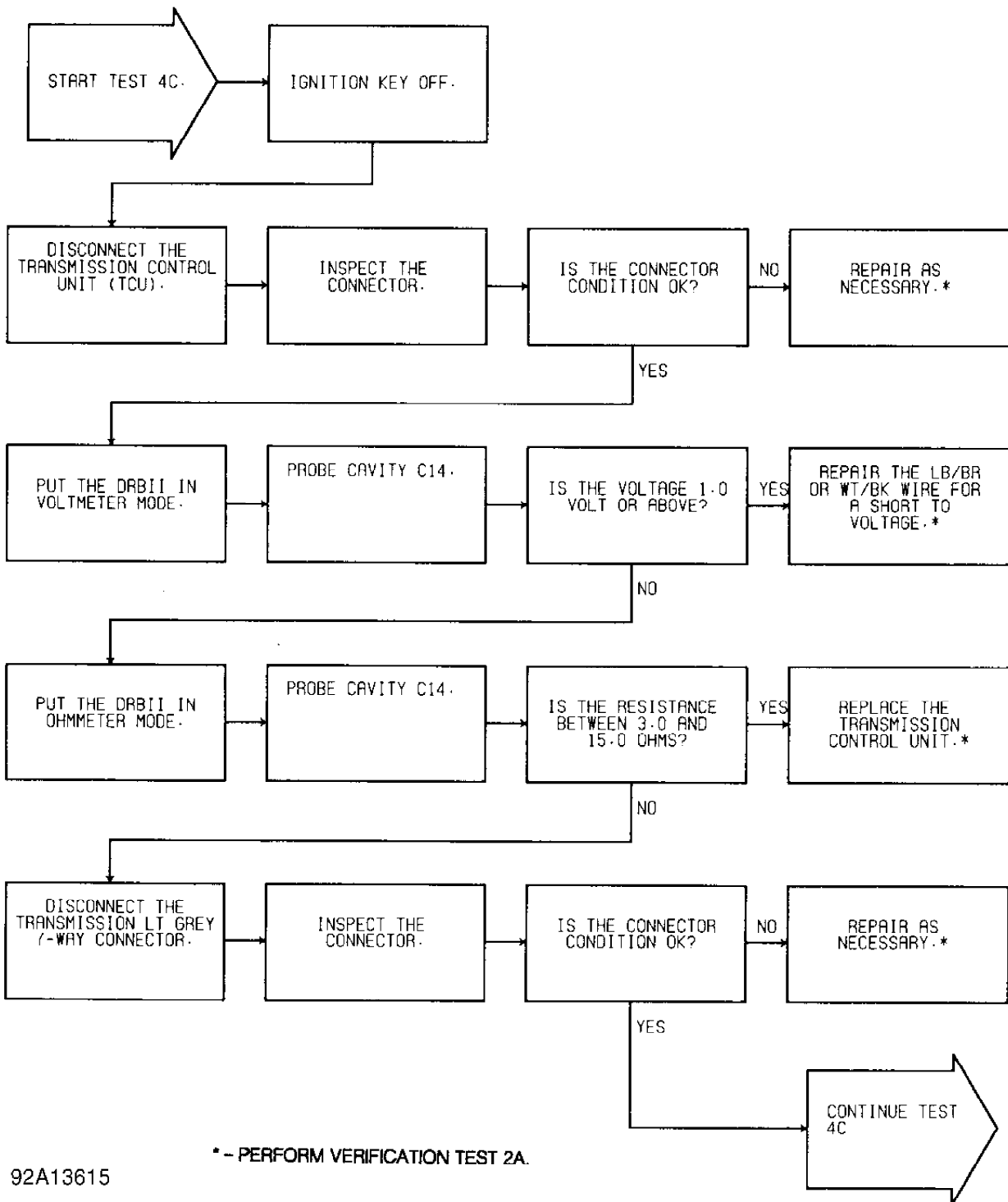


Fig. 31: Test 4B - Code 700, Testing S2 Control Wire

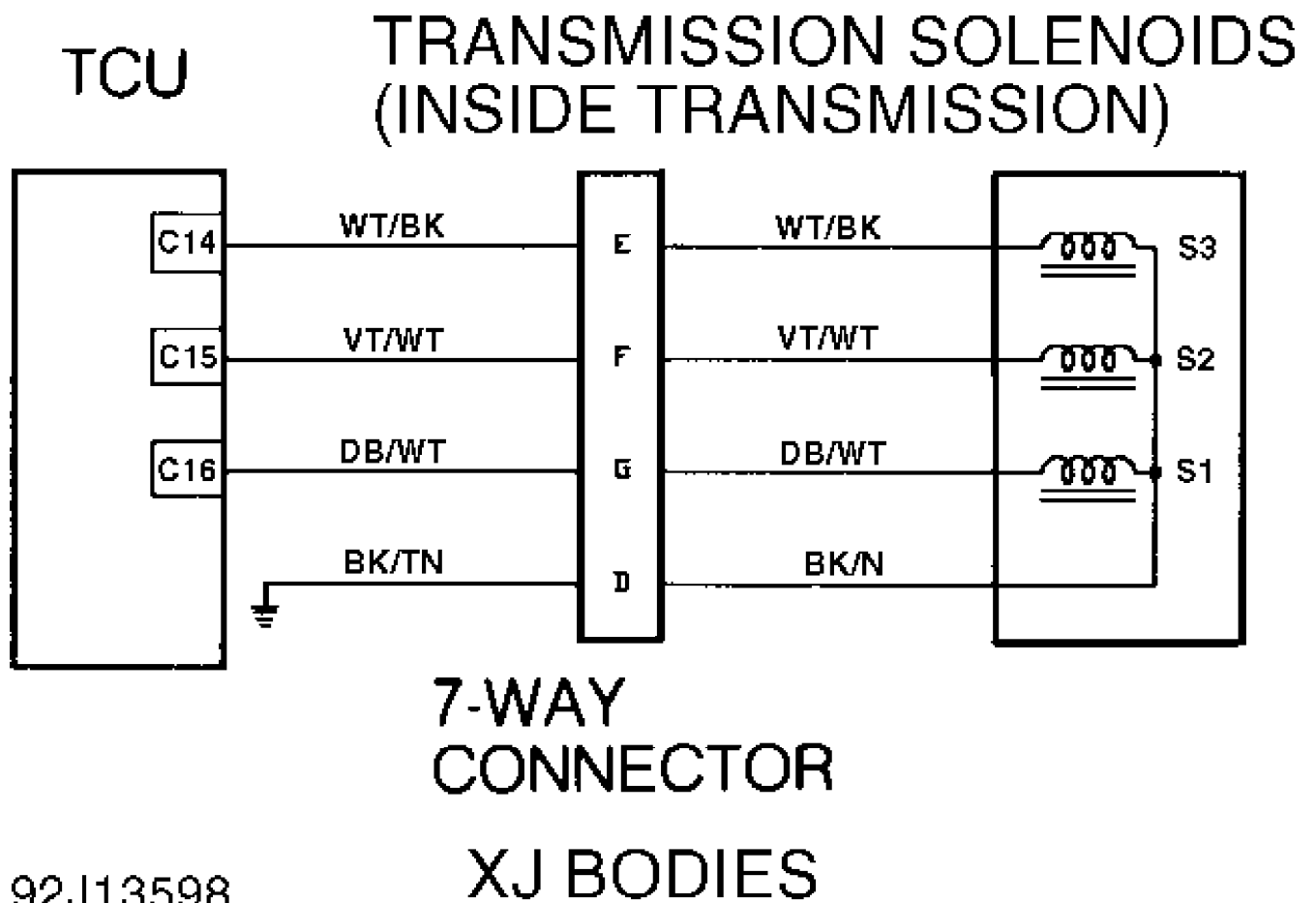
TEST 4C - CODE 700 - S3 SOLENOID CIRCUIT

Perform TEST 4A before proceeding.



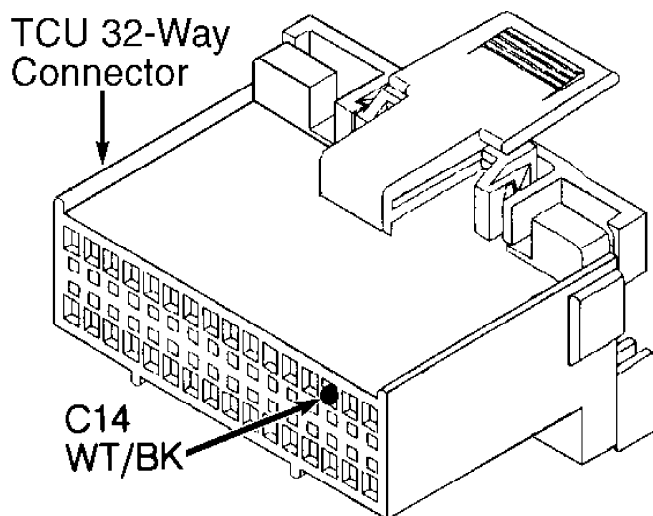
92A13615

Fig. 32: Test 4C - Code 700, Flow Chart (1 of 2)



92J13598

Fig. 33: Test 4C - Code 700, Schematic (Cherokee)



92B13616

XJ BODY

Fig. 34: Test 4C - TCU 32-Way Connector (Cavity 14, Cherokee)

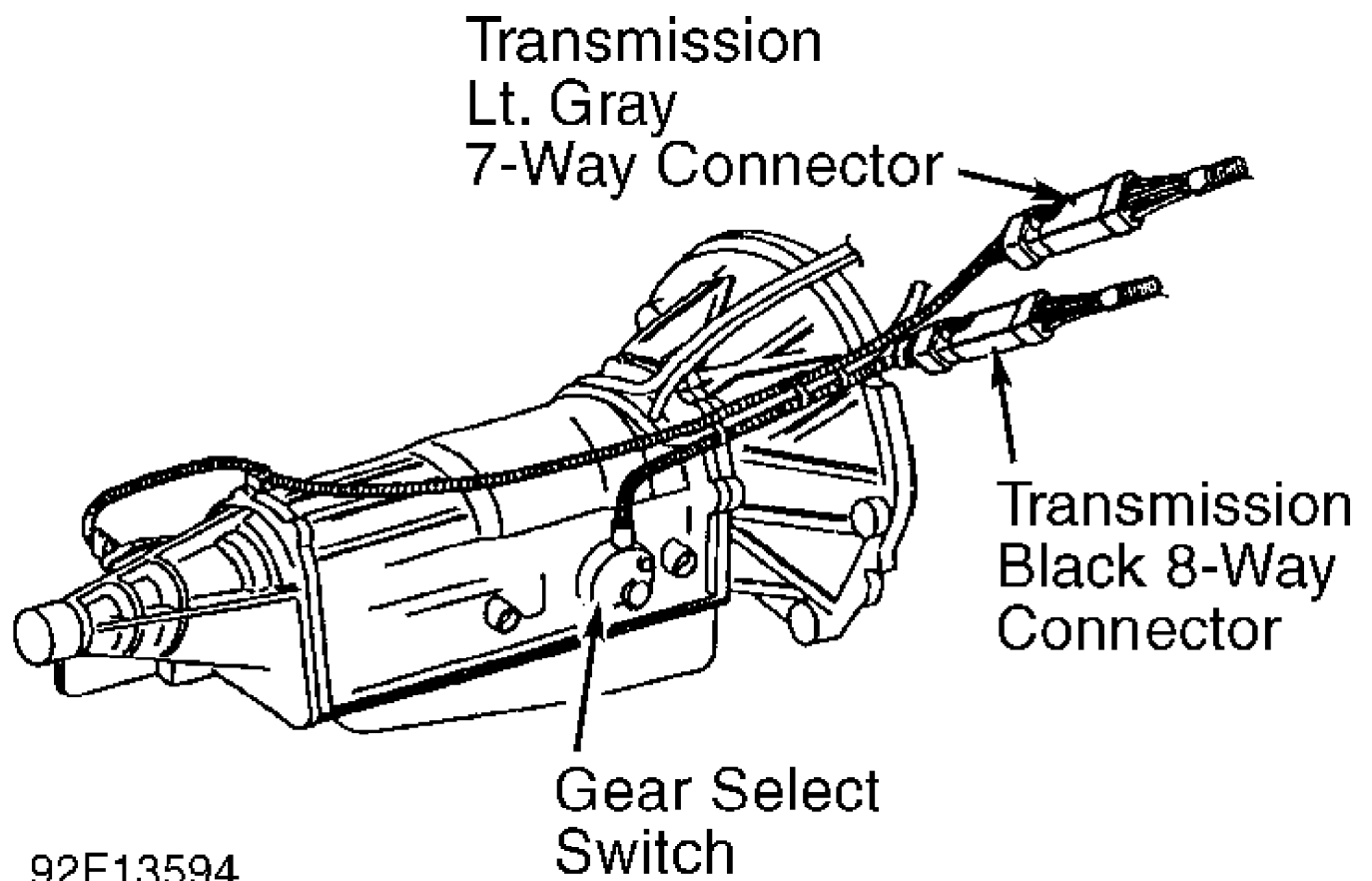
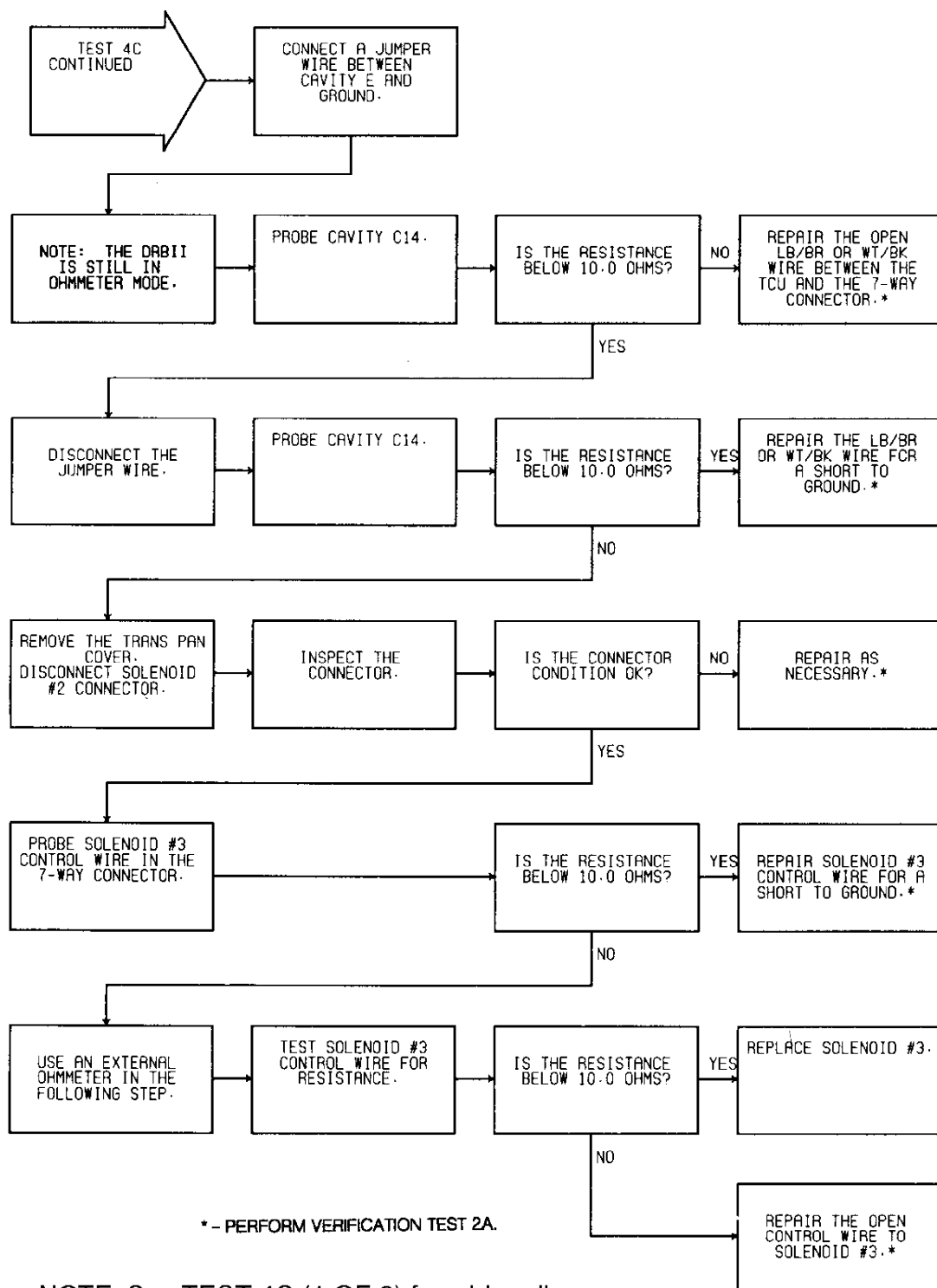
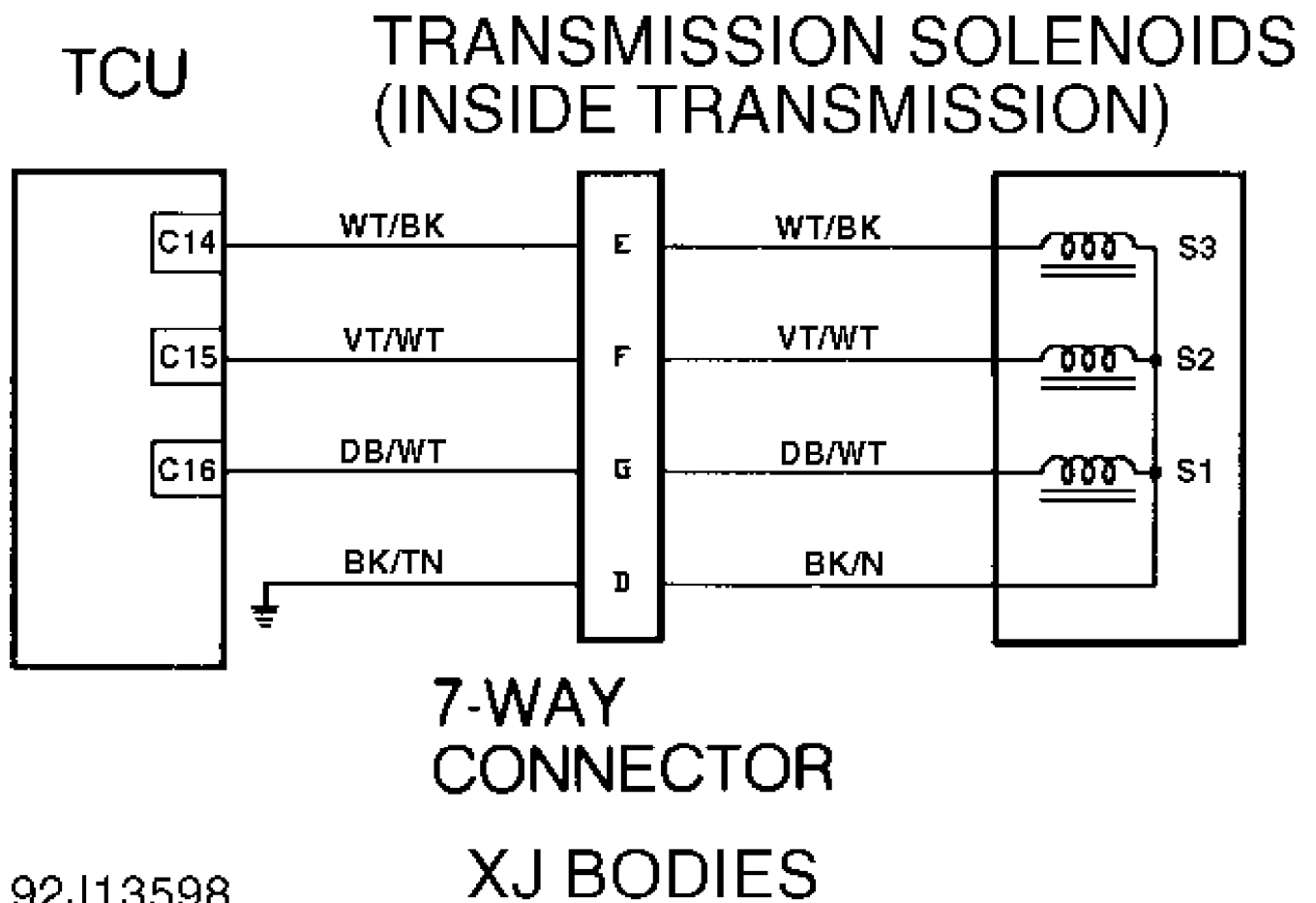


Fig. 35: Test 4C - Code 700, Location of 7-Way Connector



NOTE: See TEST 4C (1 OF 2) for wiring diagram.

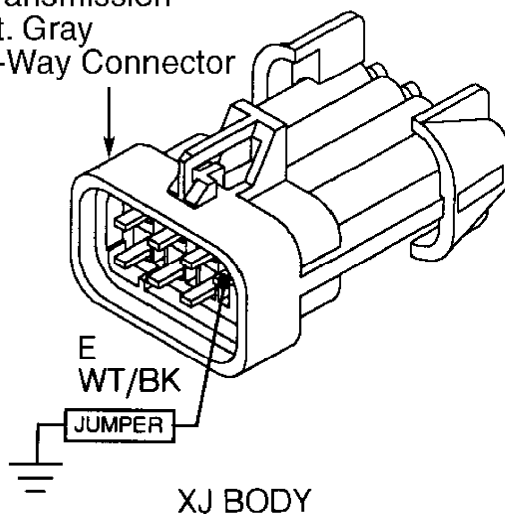
92D13618  
Fig. 36: Test 4C - Code 700, Flow Chart (2 of 2)



92J13598

Fig. 37: Test 4B - Code 700, Schematic (Cherokee)

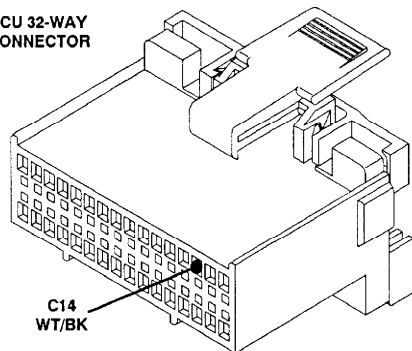
Transmission  
Lt. Gray  
7-Way Connector



92E13619

Fig. 38: Test 4C - 7-Way Connector Cavity "E" (Cherokee)

TCU 32-WAY  
CONNECTOR



C14  
WT/BK

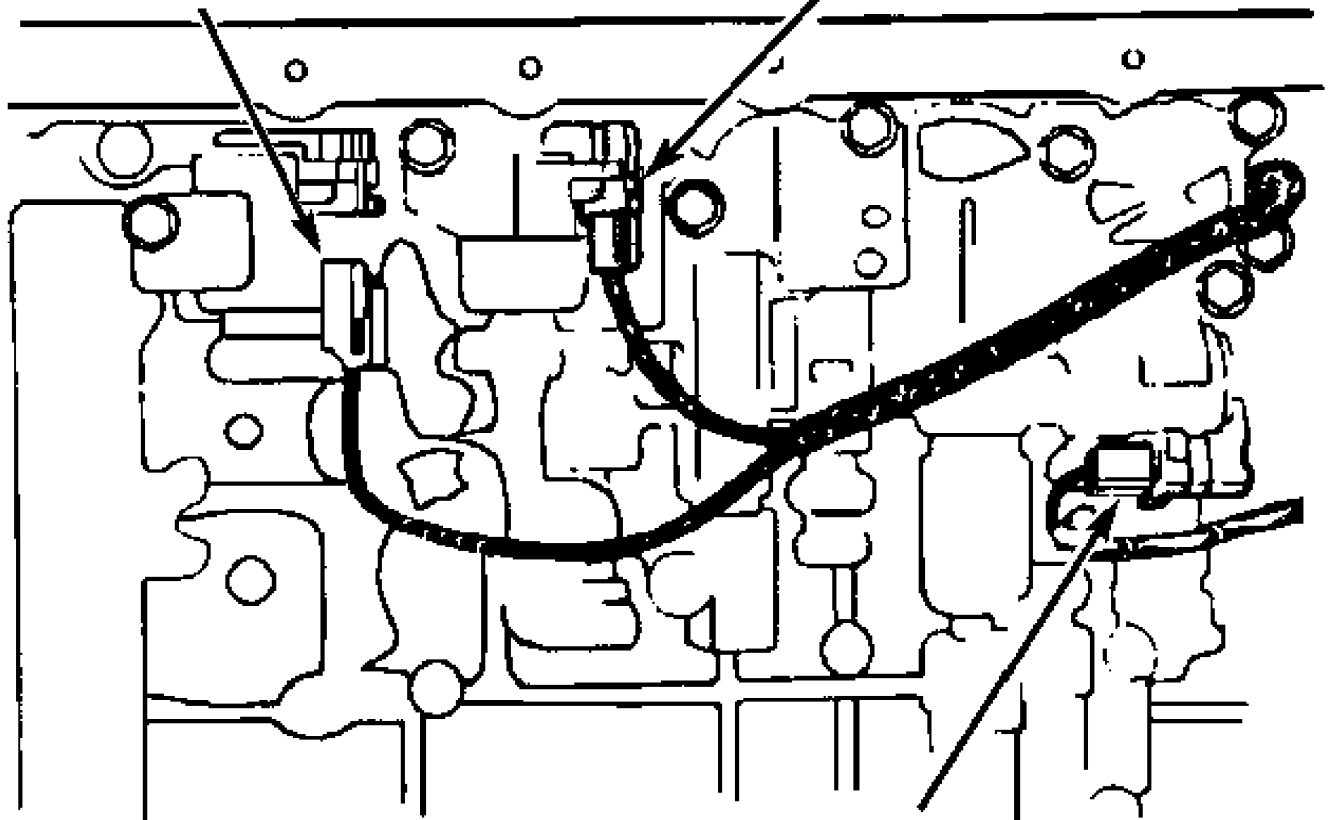
ZJ Body: LB/BR

92113621

Fig. 39: Test 4C - Code 700, TCU 32-Way Connector (Cavity 14)

Solenoid #3  
Connector

Solenoid #1  
Connector

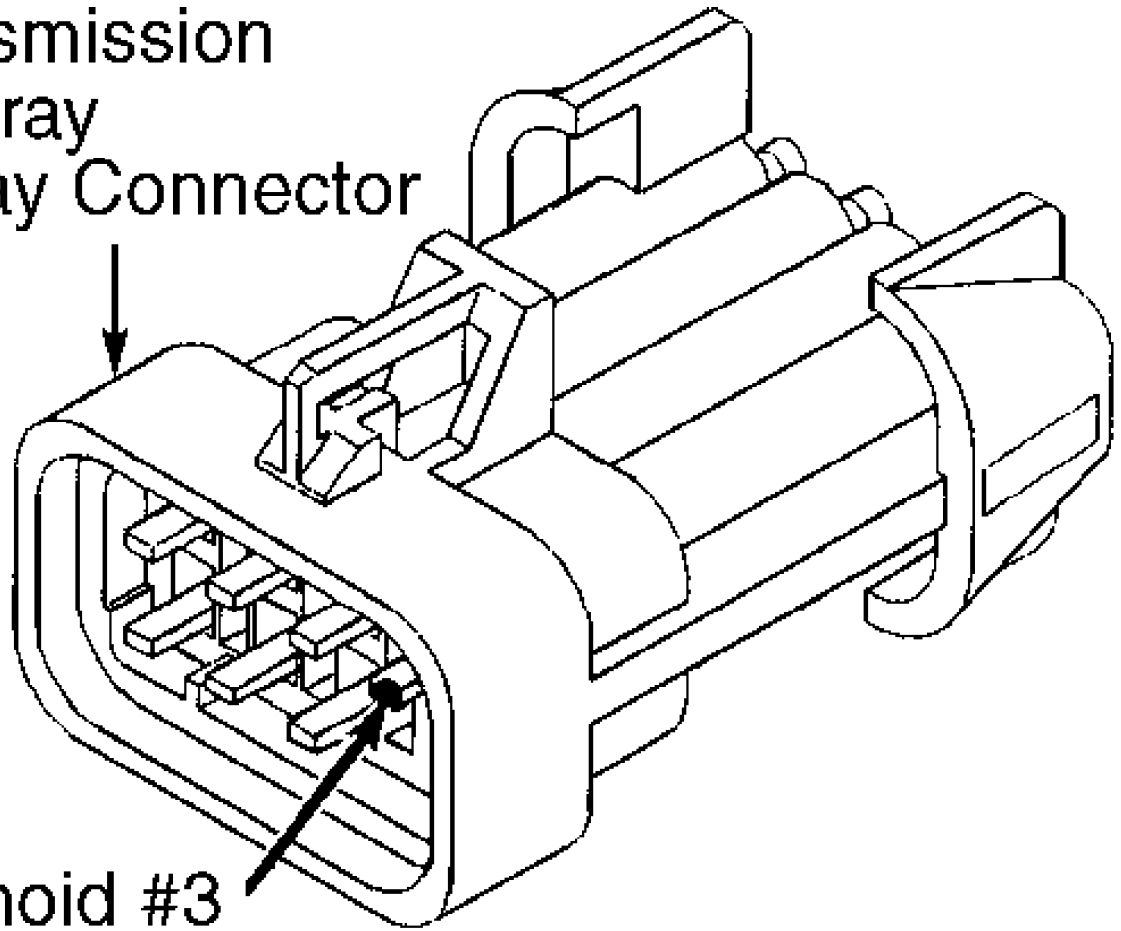


Solenoid #2  
Connector

92113605

Fig. 40: Test 4C - Code 700, Location of Solenoids

Transmission  
Lt. Gray  
7-Way Connector



Solenoid #3  
Connector

CAV	XJ	ZJ
E	WT/BK	LB/BR

92J13622

Fig. 41: Test 4C - Code 700, Solenoid No. 1 Wire (Cavity "E")

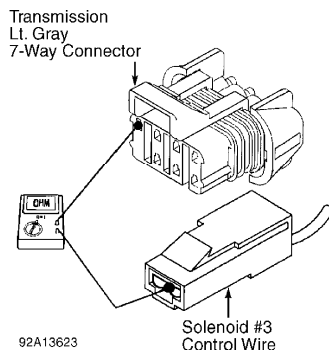


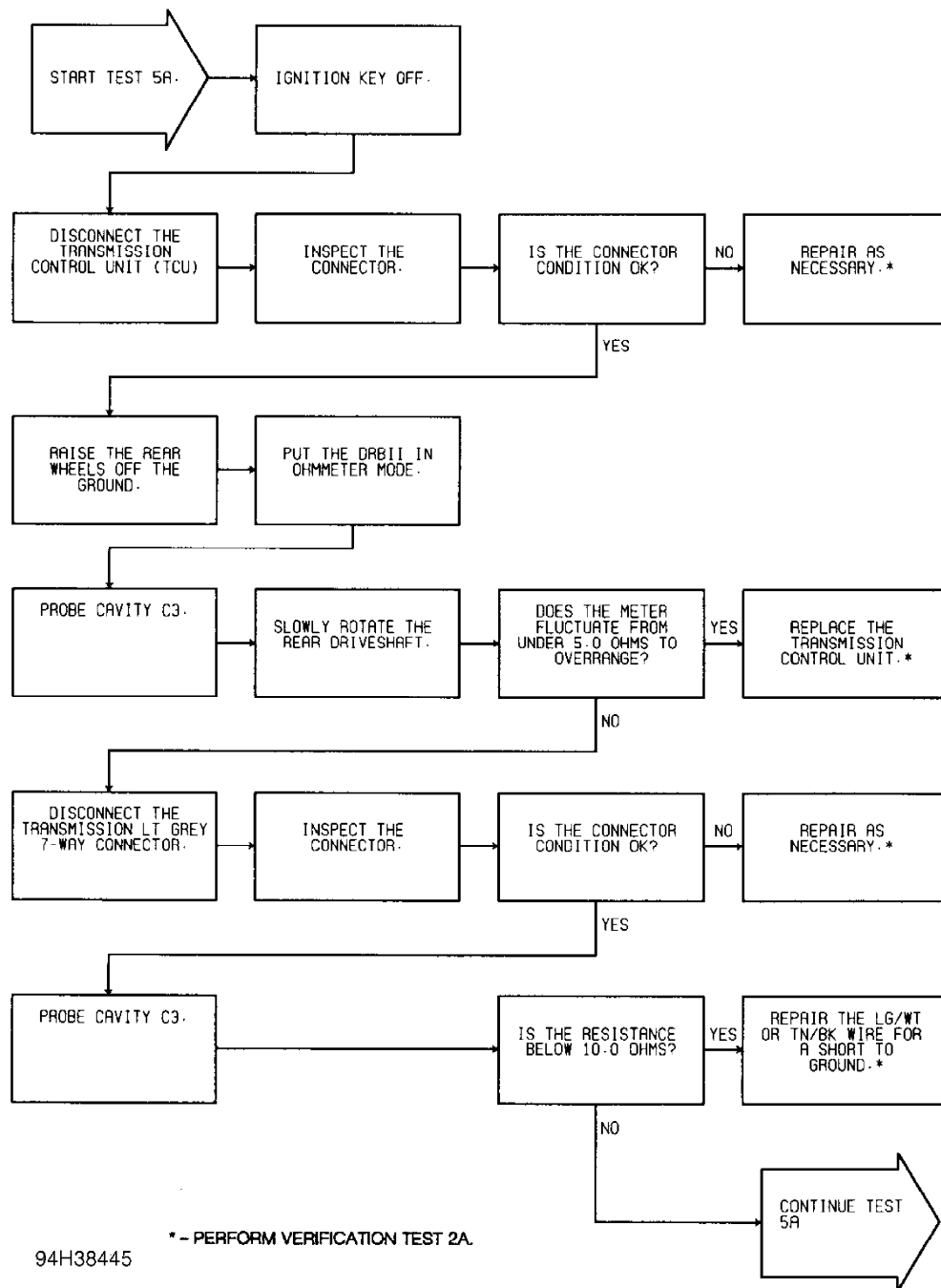
Fig. 42: Test 4C - Code 700, Testing S3 Control Wire



## TEST 5A - CODE 702 - SPEED SENSOR CIRCUIT

NOTE: Perform TEST 1A - VERIFICATION OF COMPLAINT before proceeding.

Perform TEST 1A before proceeding.



94H38445

Fig. 43: Test 5A - Code 702, Flow Chart (1 of 2)

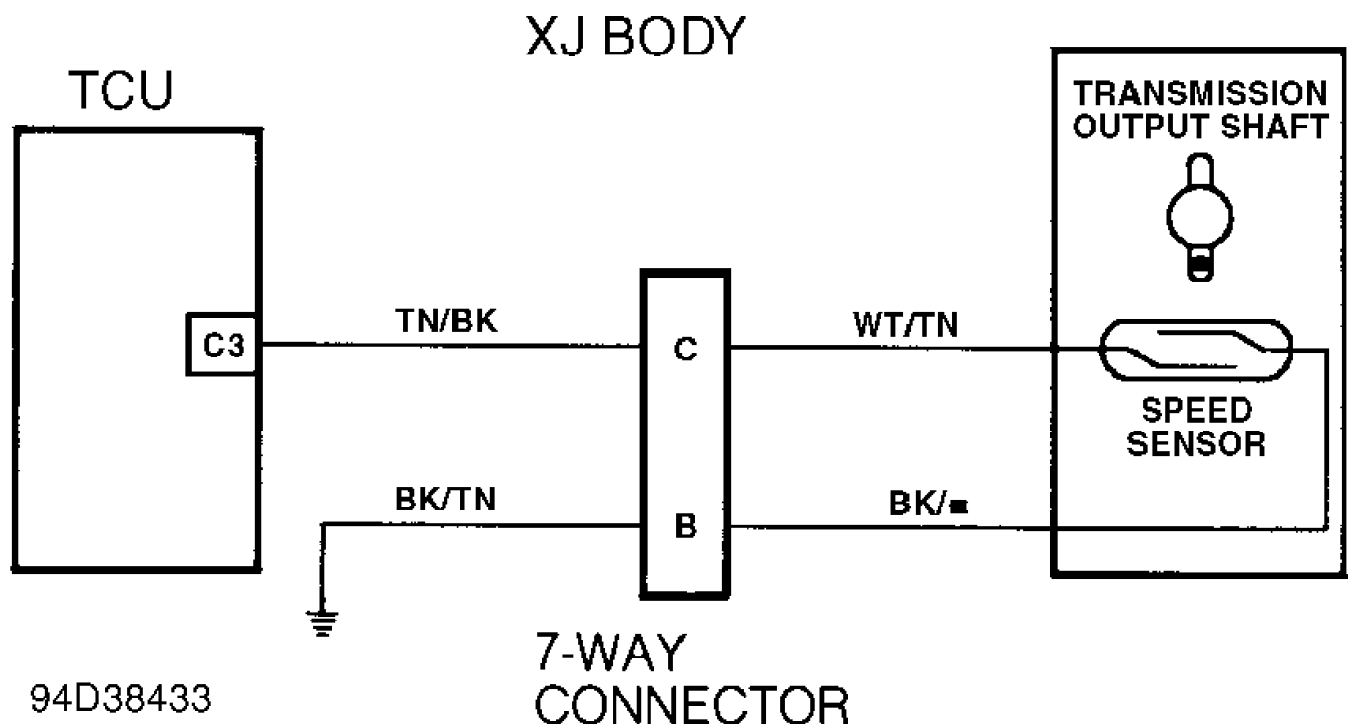


Fig. 44: Test 5A - Code 702, Speed Sensor Schematic (Cherokee)

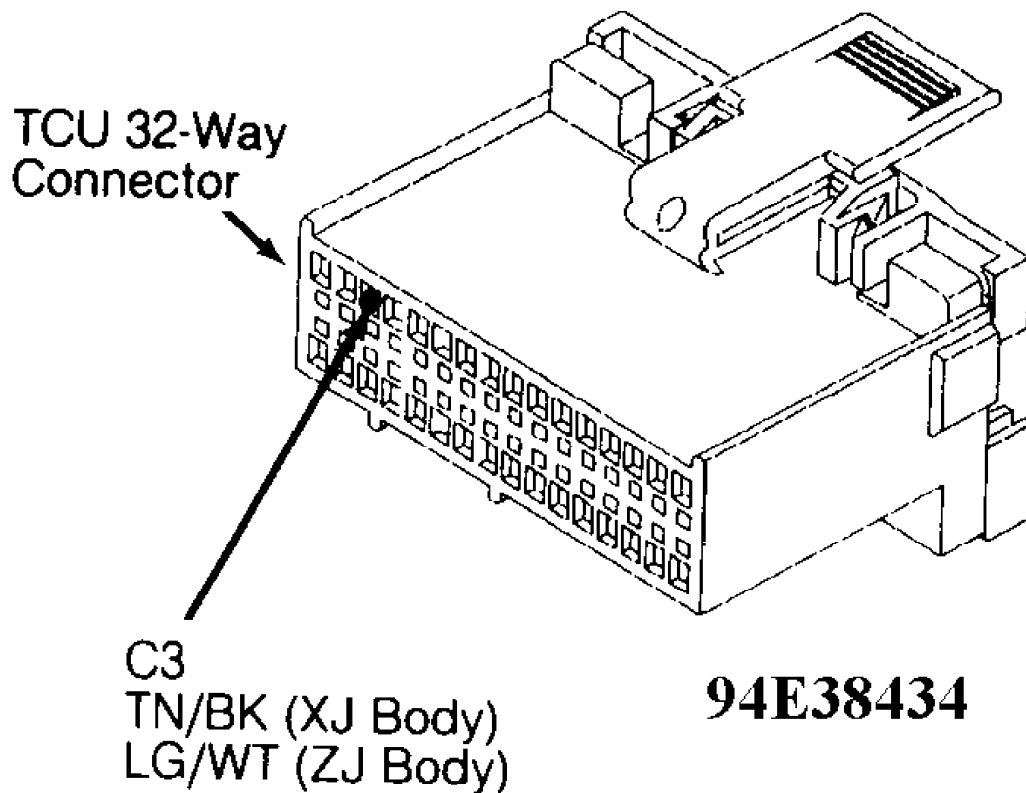
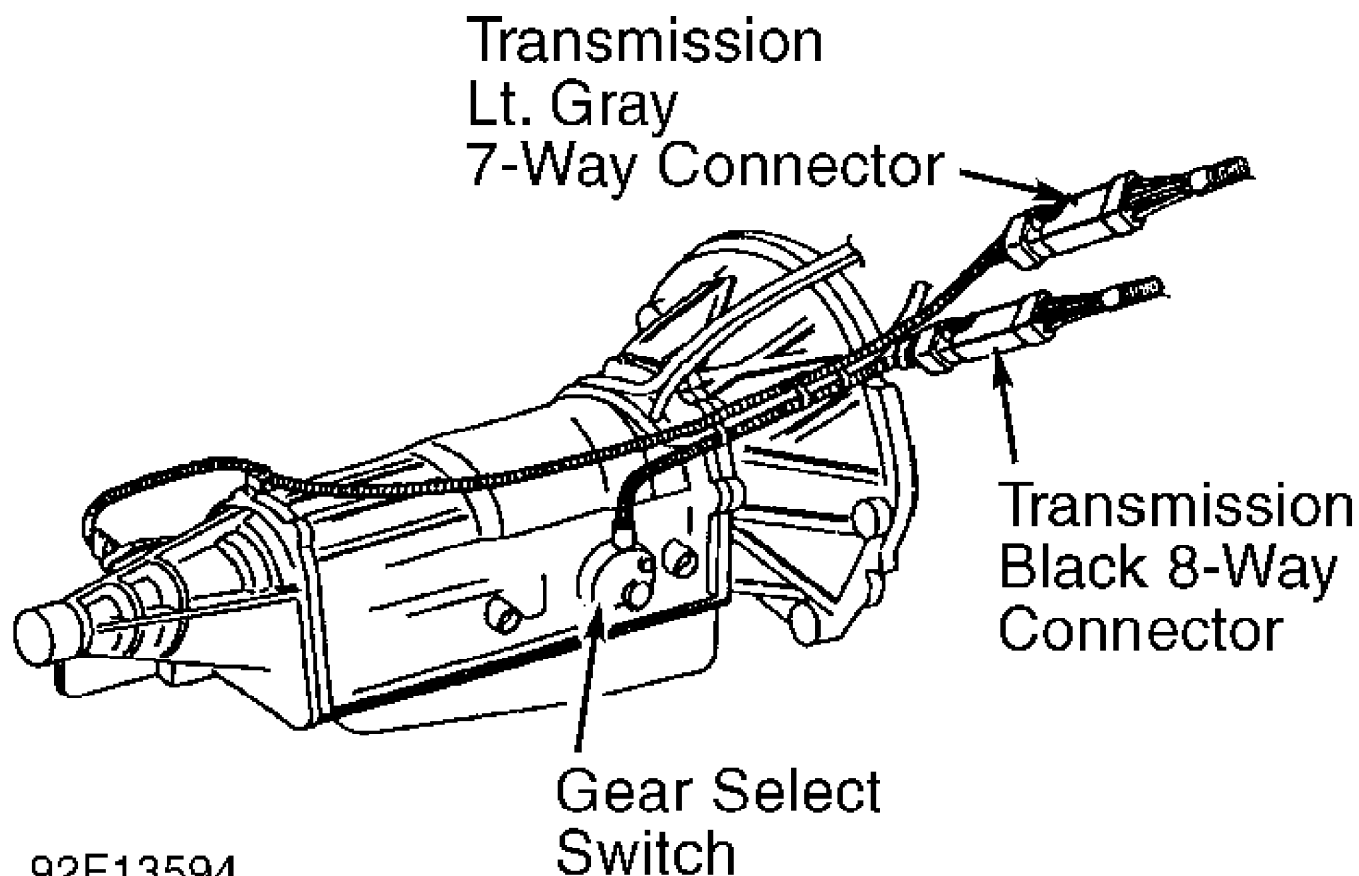
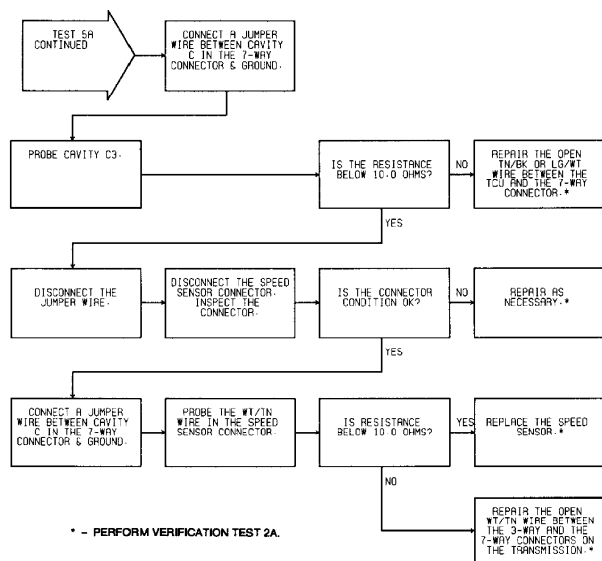


Fig. 45: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)



92F13594

Fig. 46: Test 5A - Code 702, Location of 7-Way Connector



NOTE: See TEST 5A (1 OF 2) for wiring diagram.

94F38435

Fig. 47: Test 5A - Code 702, Flow Chart (2 of 2)

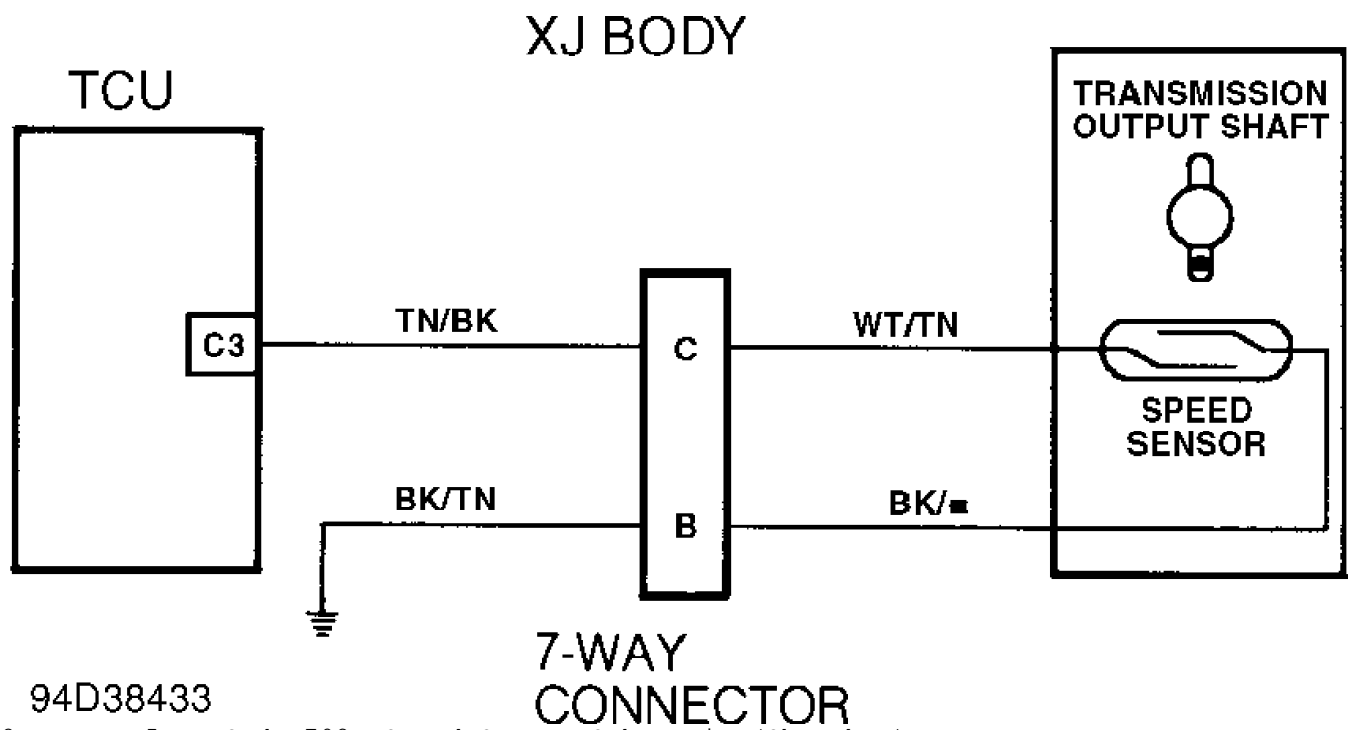


Fig. 48: Test 5A - Code 702, Speed Sensor Schematic (Cherokee)

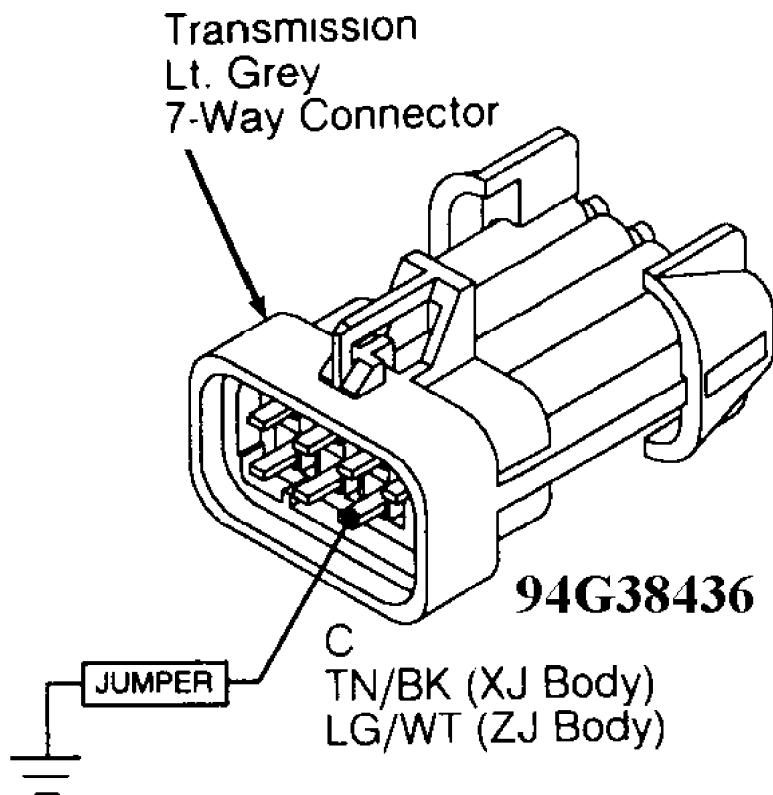


Fig. 49: Test 5A - Transmission 7-Way Connector (Male Side)

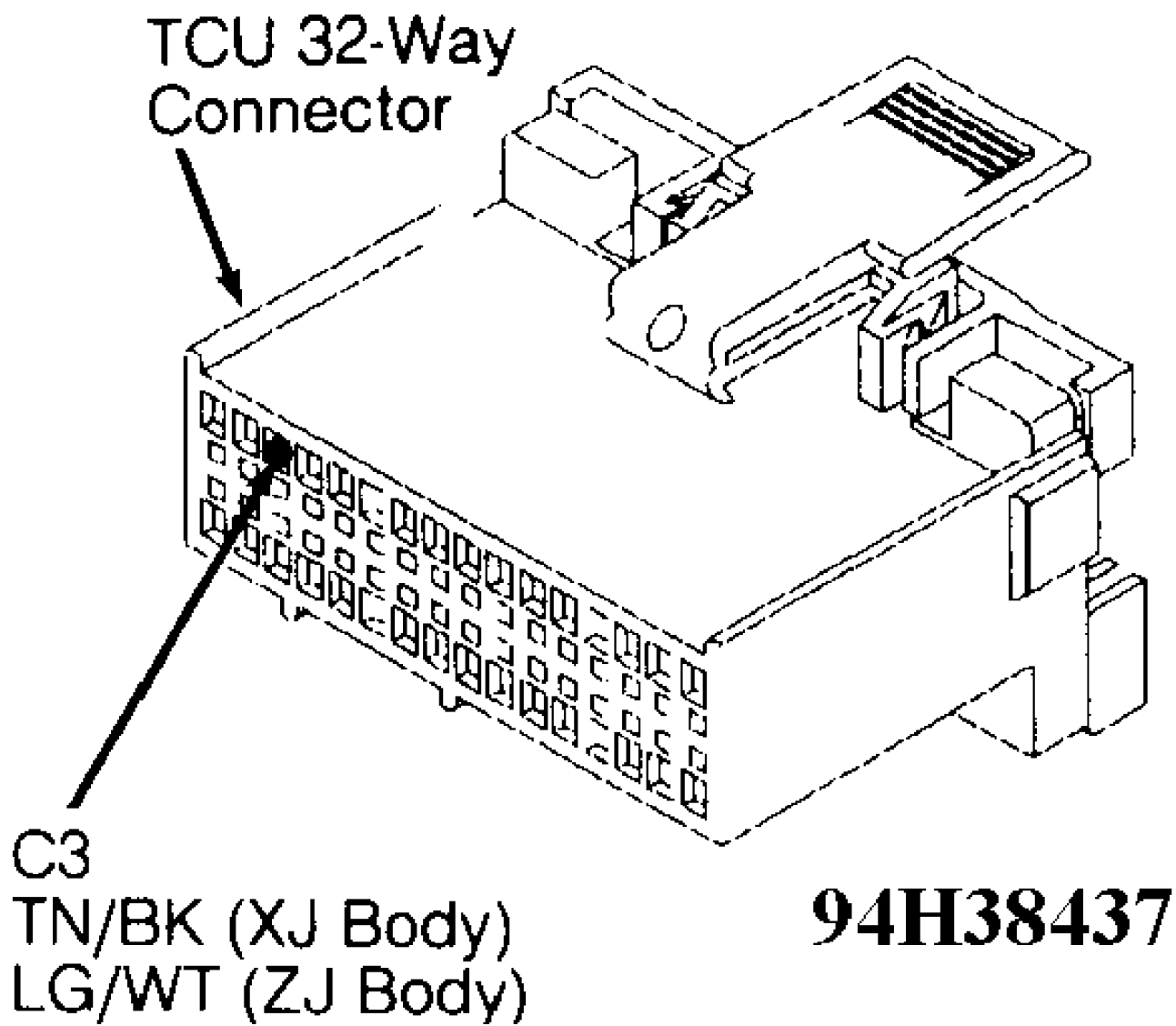


Fig. 50: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)

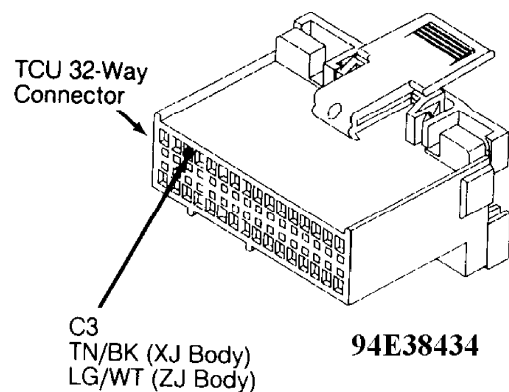
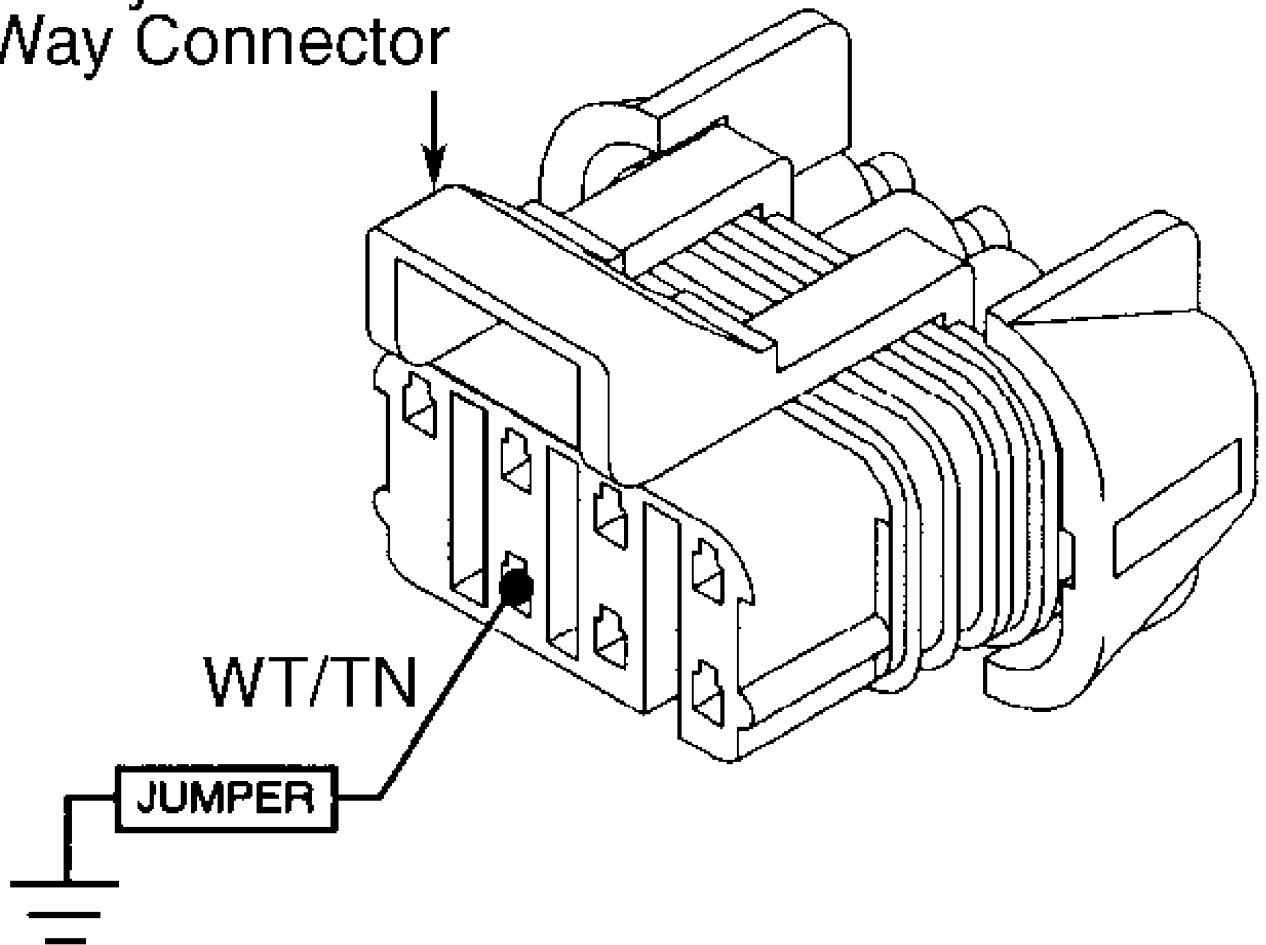


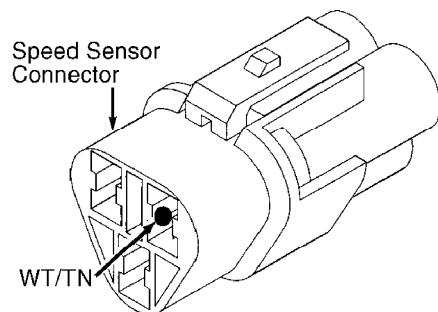
Fig. 51: Test 5A - Code 702, TCU 32-Way Connector (Cavity 3)

# Transmission Lt. Gray 7-Way Connector



92H14255

Fig. 52: Test 5A - Transmission 7-Way Connector (Female Side)

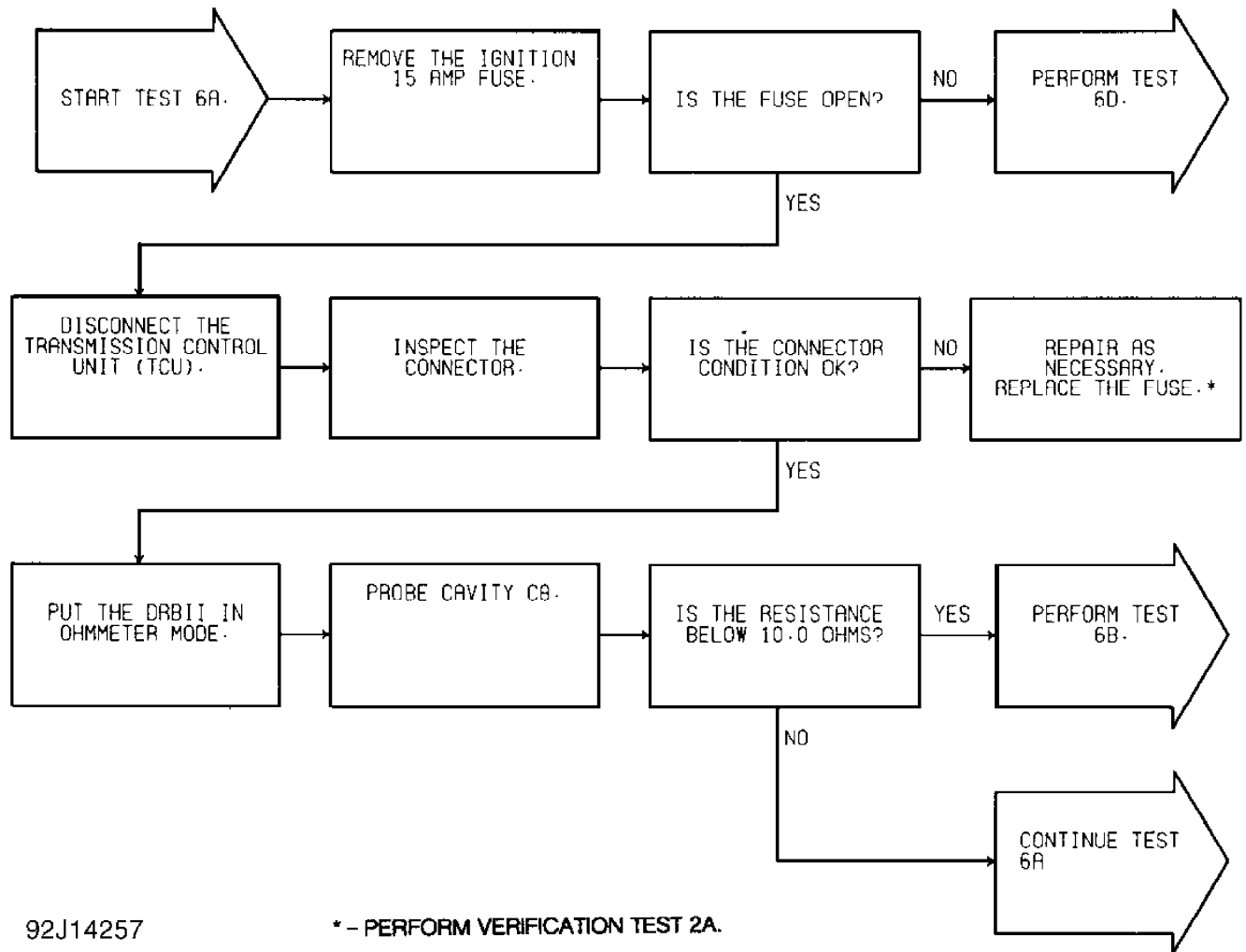


92H14256

Fig. 53: Test 5A - Code 702, View of Speed Sensor Connector

TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT

Perform TEST 1A before proceeding.

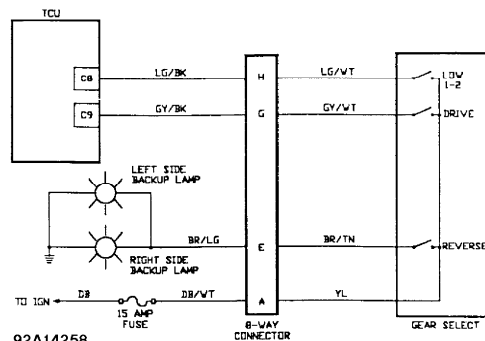


92J14257

\* - PERFORM VERIFICATION TEST 2A.

Fig. 54: Test 6A - Code 703, Flow Chart (1 of 2)

MJ and XJ Bodies



92A14258

Fig. 55: Test 6A - Gear Select Switch Schematic (Cherokee)

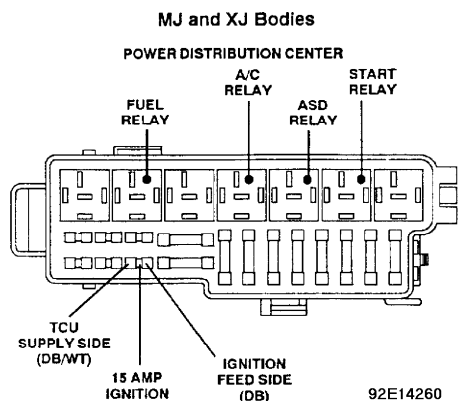
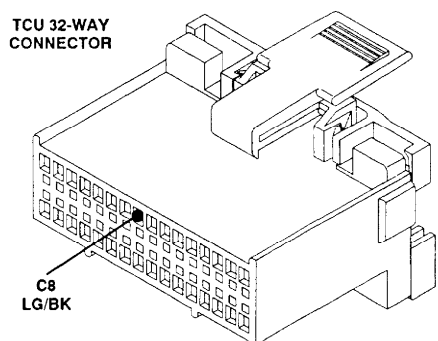
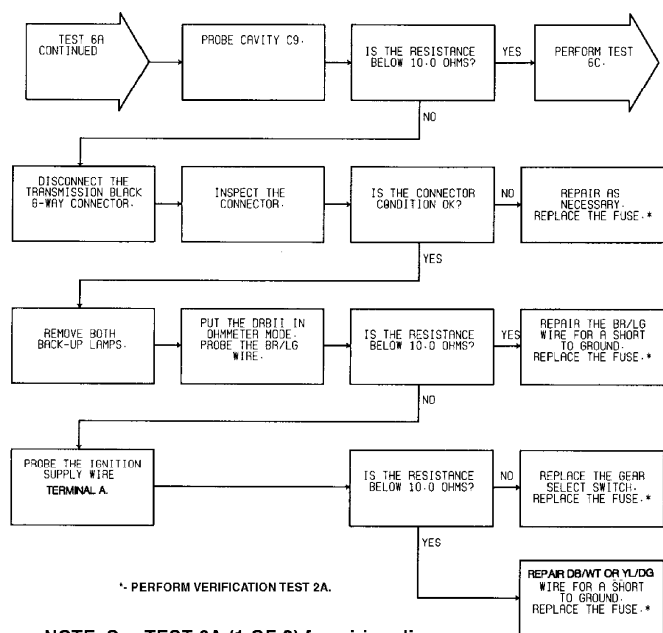


Fig. 56: Test 6A - Location of Gear Select Switch Fuse (Cherokee)



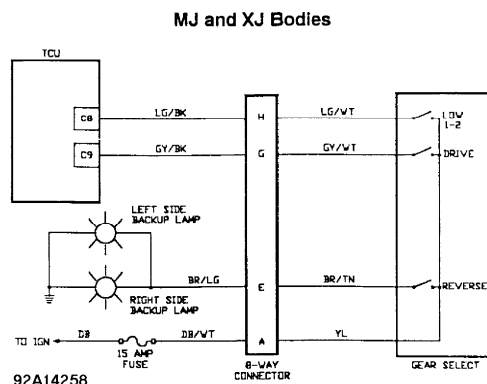
**ZJ Body: LG** 92G14262  
Fig. 57: Test 6A - TCU 32-Way Connector (Cavity 8)



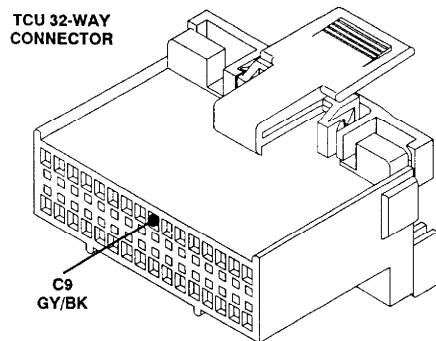
NOTE: See TEST 6A (1 OF 2) for wiring diagram.

92H14263  
Fig. 58: Test 6A - Code 703, Flow Chart (2 of 2)

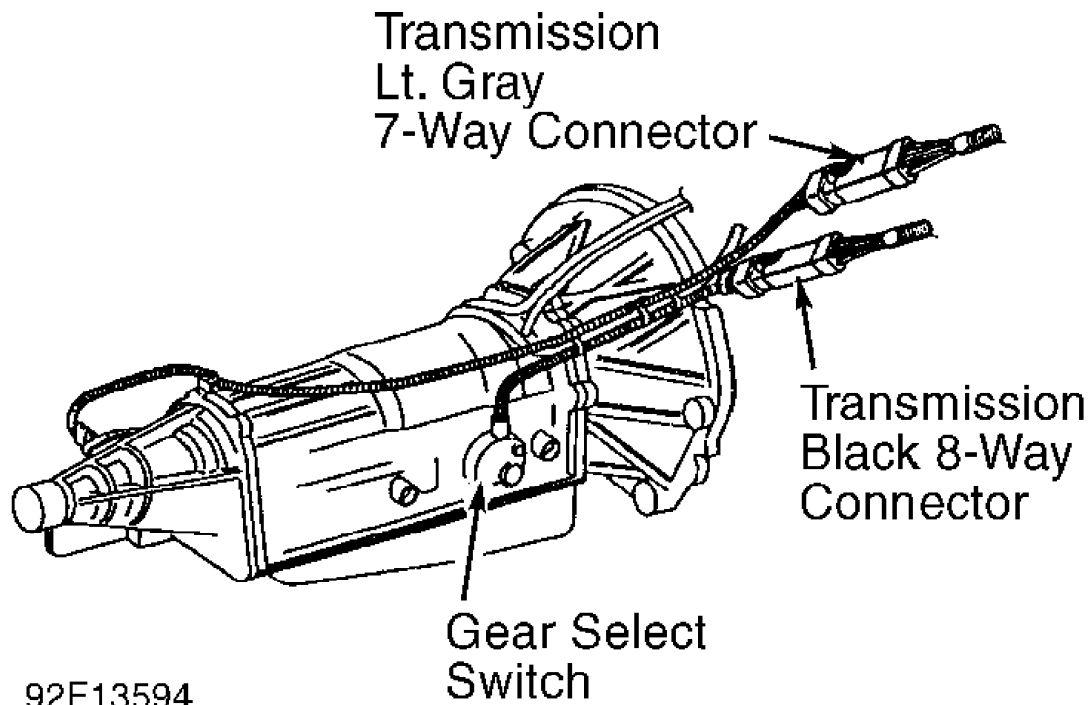




92A14258  
Fig. 59: Test 6A - Gear Select Switch Schematic (Cherokee)

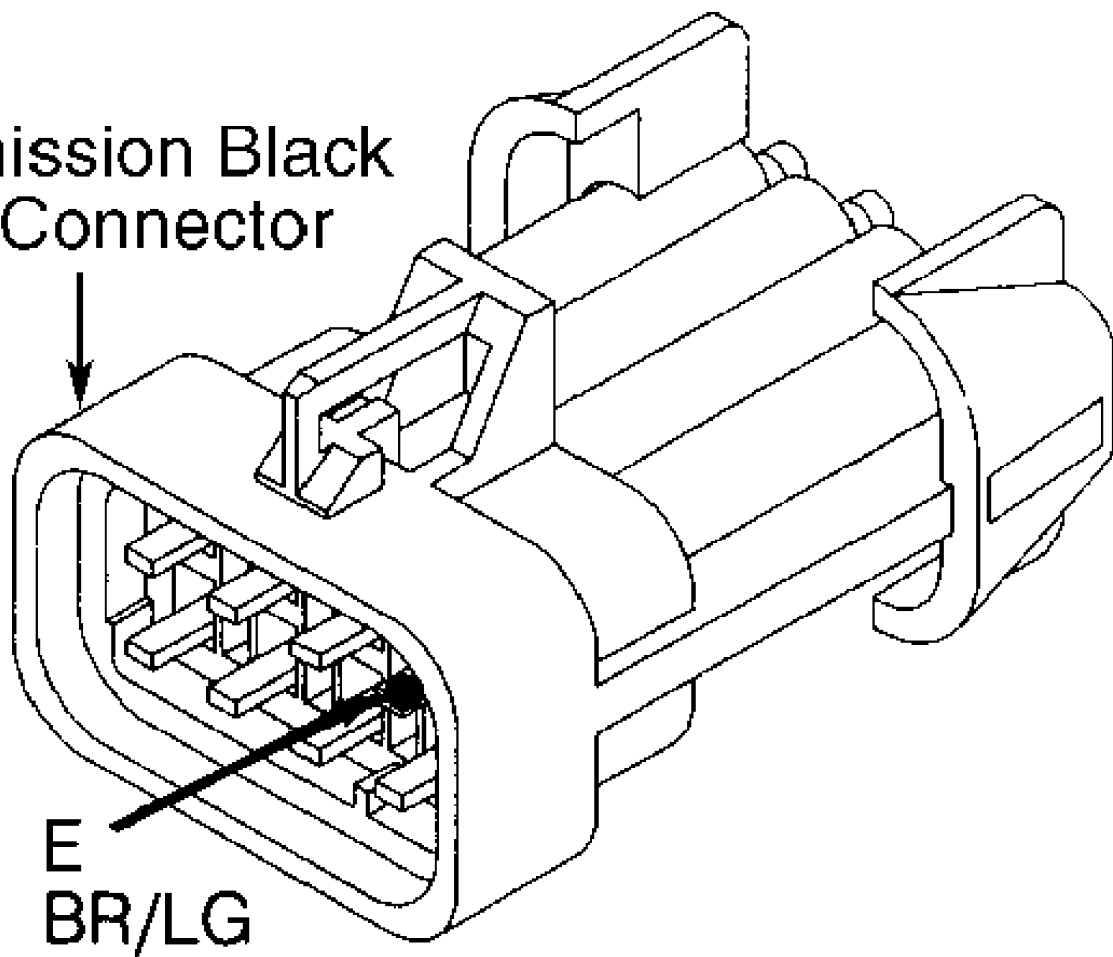


ZJ Body: DG  
92I14264  
Fig. 60: Test 6A - Code 703, TCU 32-Way Connector (Cavity 9)



92F13594  
Fig. 61: Test 6A - Code 703, Location of Gear Select Switch

## Transmission Black 8-Way Connector

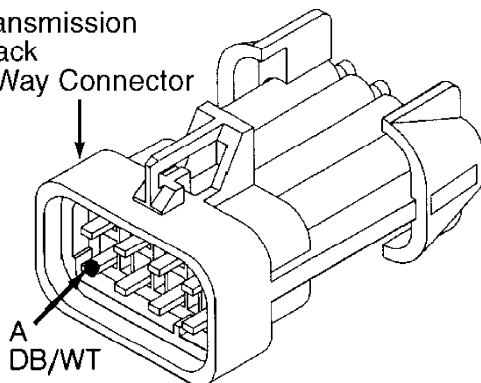


92J14265

Fig. 62: Test 6A - Code 703, 8-Way Black Connector Cavity "E"

XJ BODY

## Transmission Black 8-Way Connector



92A14266

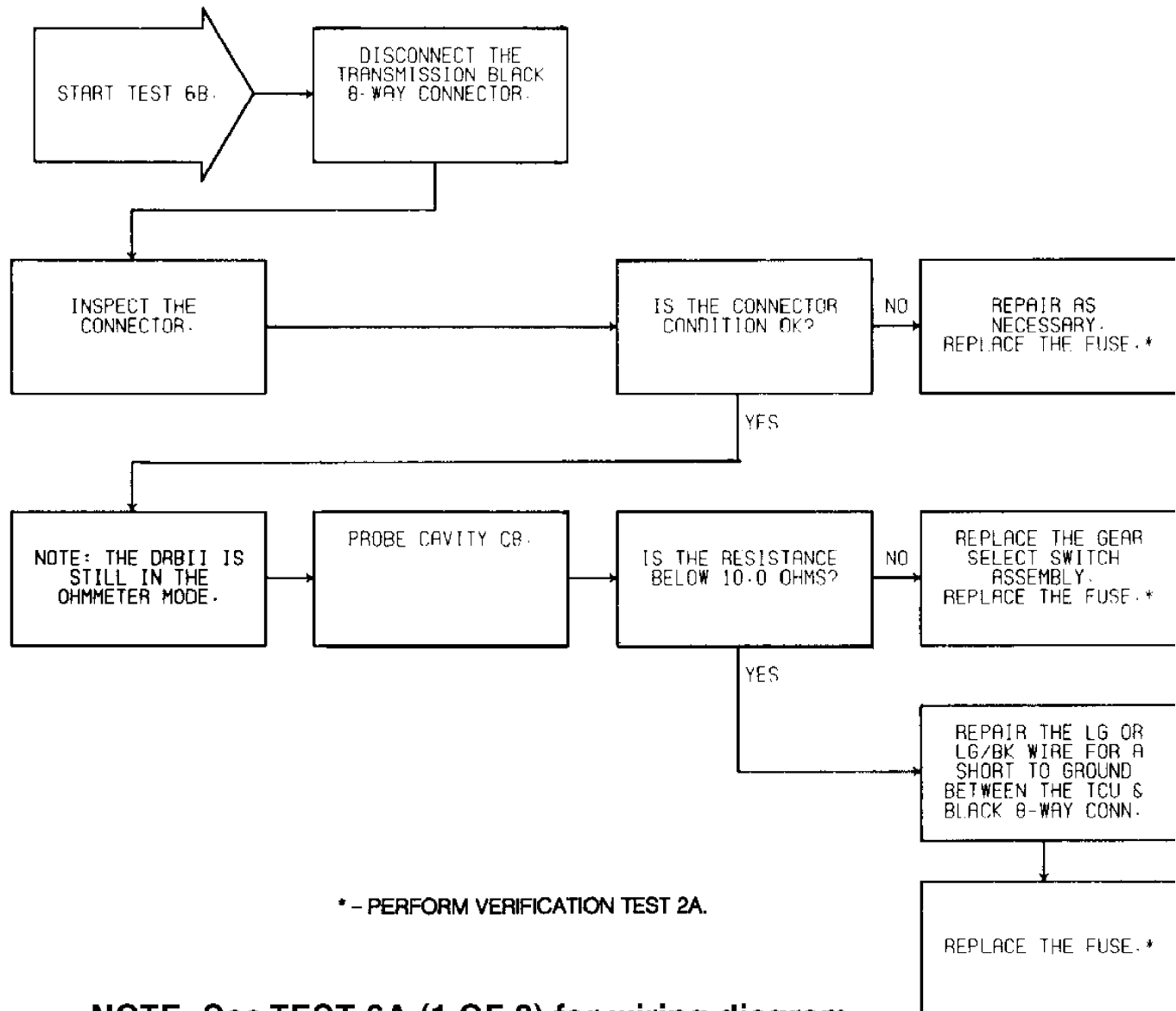
Fig. 63: Test 6A - 8-Way Black Connector Cavity "A" (Cherokee)

## TEST 6B - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT

before proceeding.

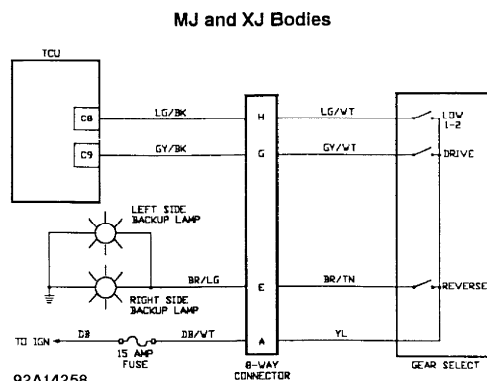
**Perform TEST 6A before proceeding.**



**NOTE: See TEST 6A (1 OF 2) for wiring diagram.**

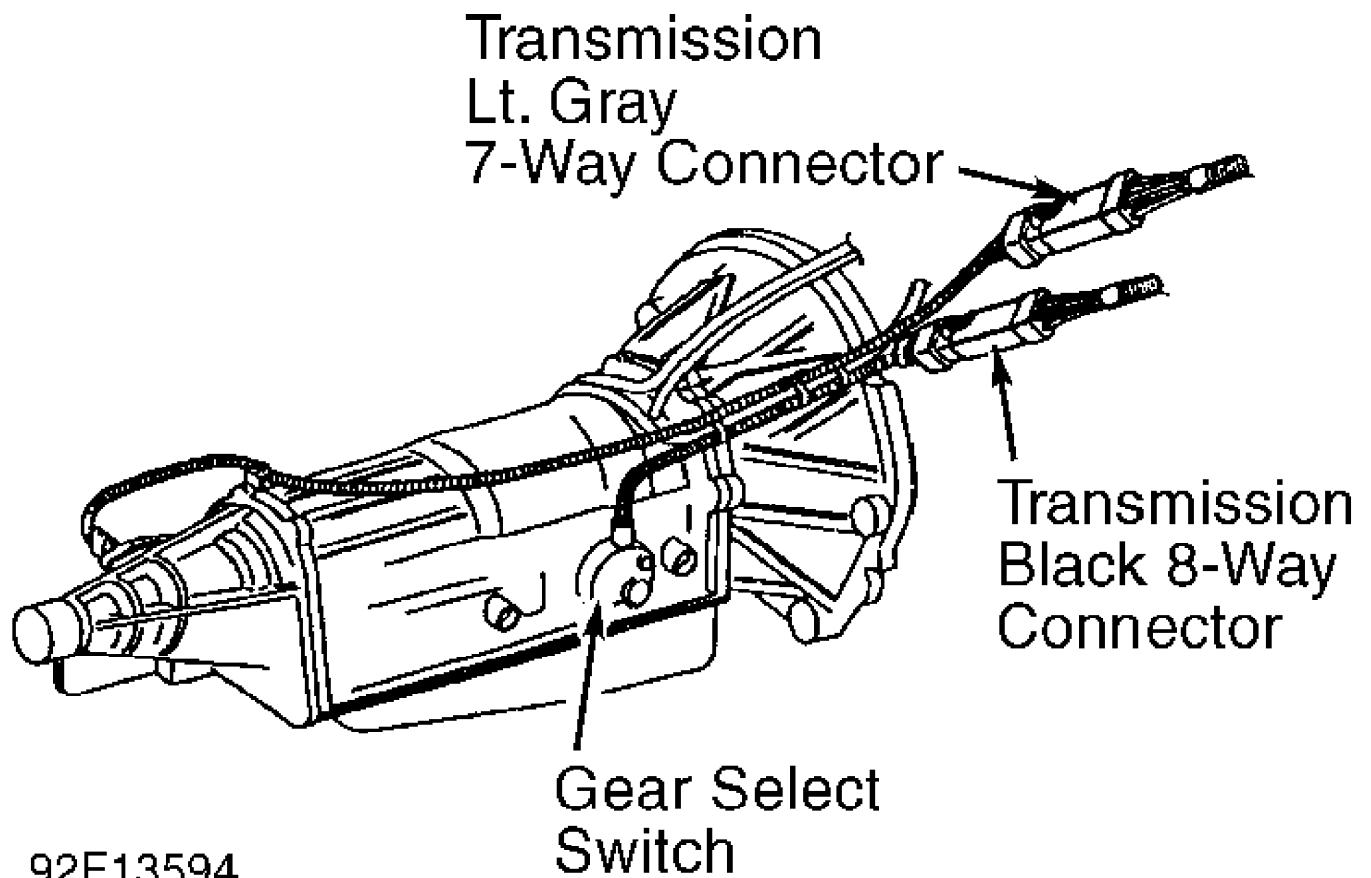
92C14268

Fig. 64: Test 6B - Code 703, Flow Chart



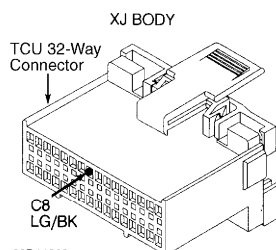
92A14258

Fig. 65: Test 6B - Gear Select Switch Schematic (Cherokee)



92F13594

Fig. 66: Test 6B - Code 703, Location of Gear Select Switch



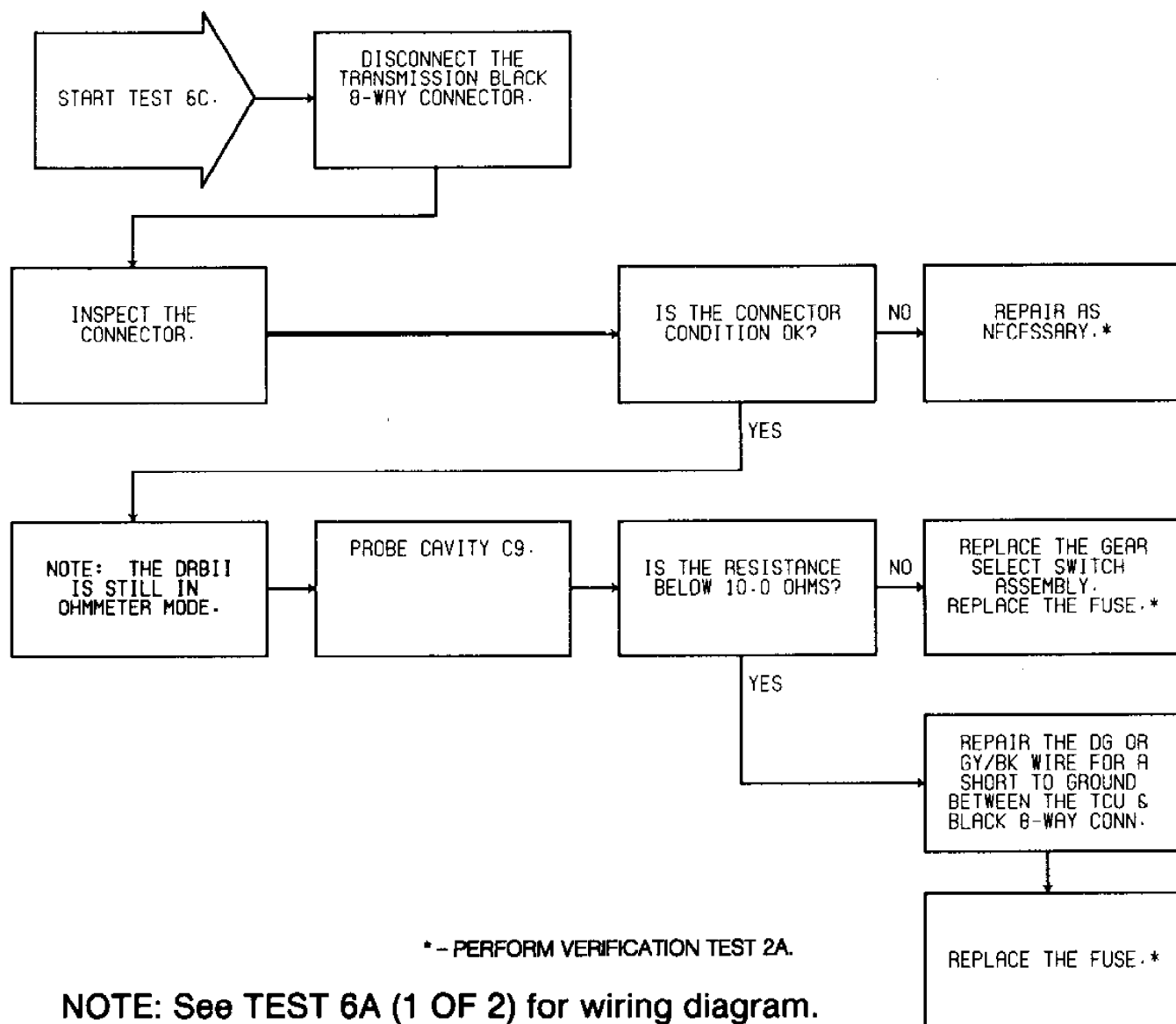
92D14269

Fig. 67: Test 6B - TCU 32-Way Connector (Cavity 8, Cherokee)

TEST 6C - CODE 703 - GEAR SELECT SWITCH CIRCUIT

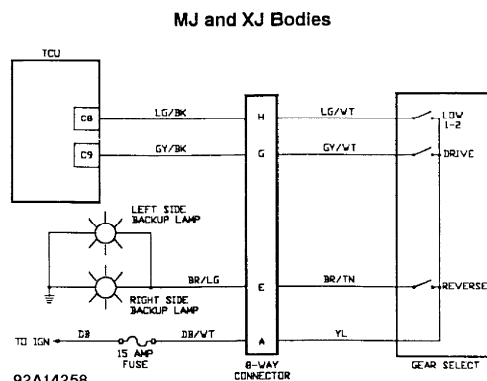
NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

**Perform TEST 6A before proceeding.**



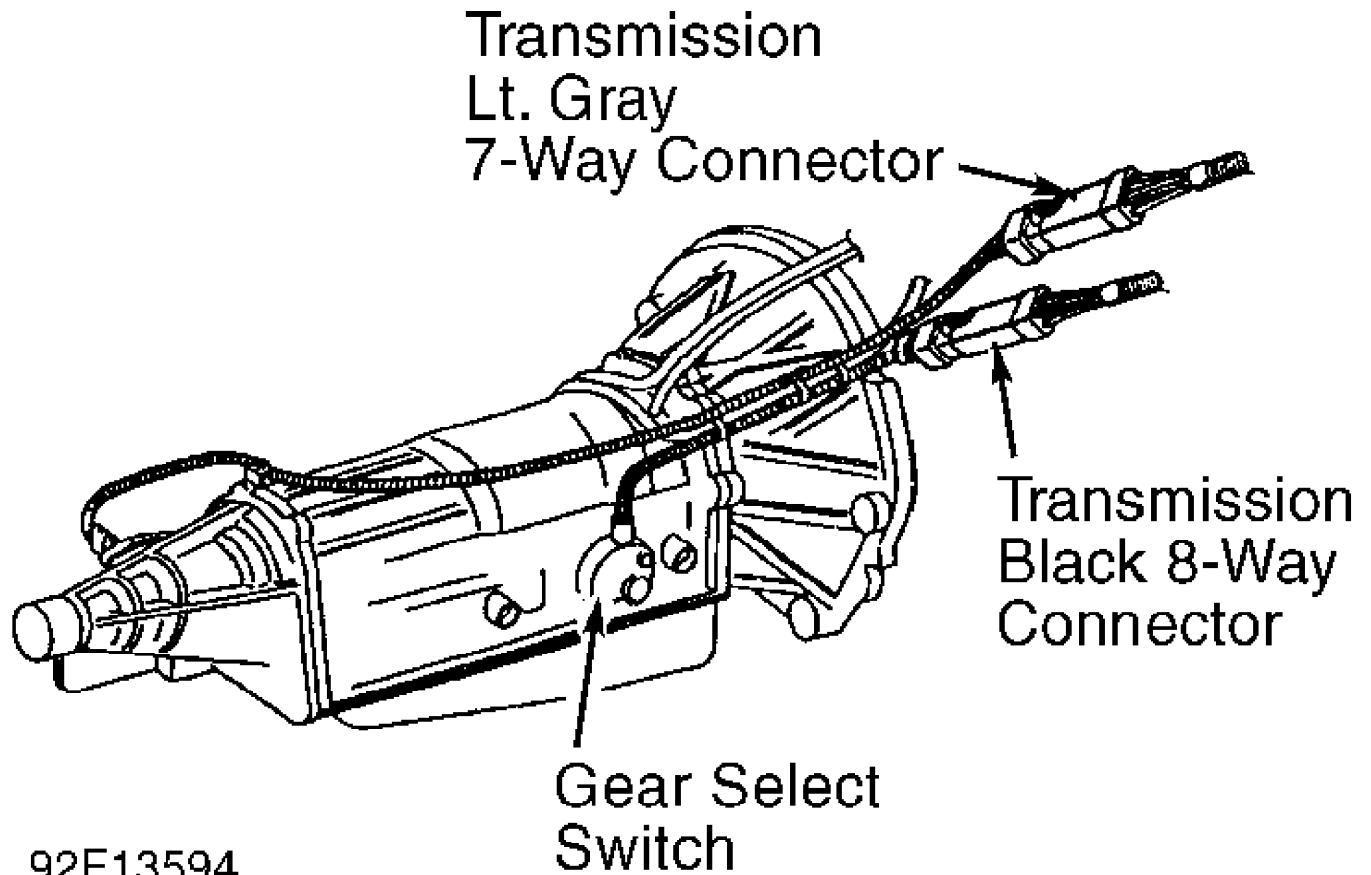
92H14271

Fig. 68: Test 6C - Code 703, Flow Chart



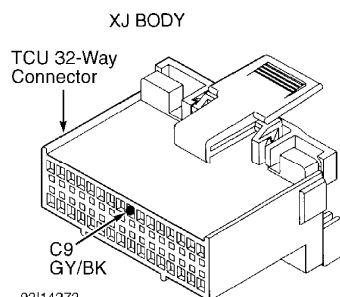
92A14258

Fig. 69: Test 6C - Gear Select Switch Schematic (Cherokee)



92F13594

Fig. 70: Test 6C - Code 703, Location of Gear Select Switch



92114272

Fig. 71: Test 6C - TCU 32-Way Connector (Cavity 9, Cherokee)

## TEST 6D - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6A - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

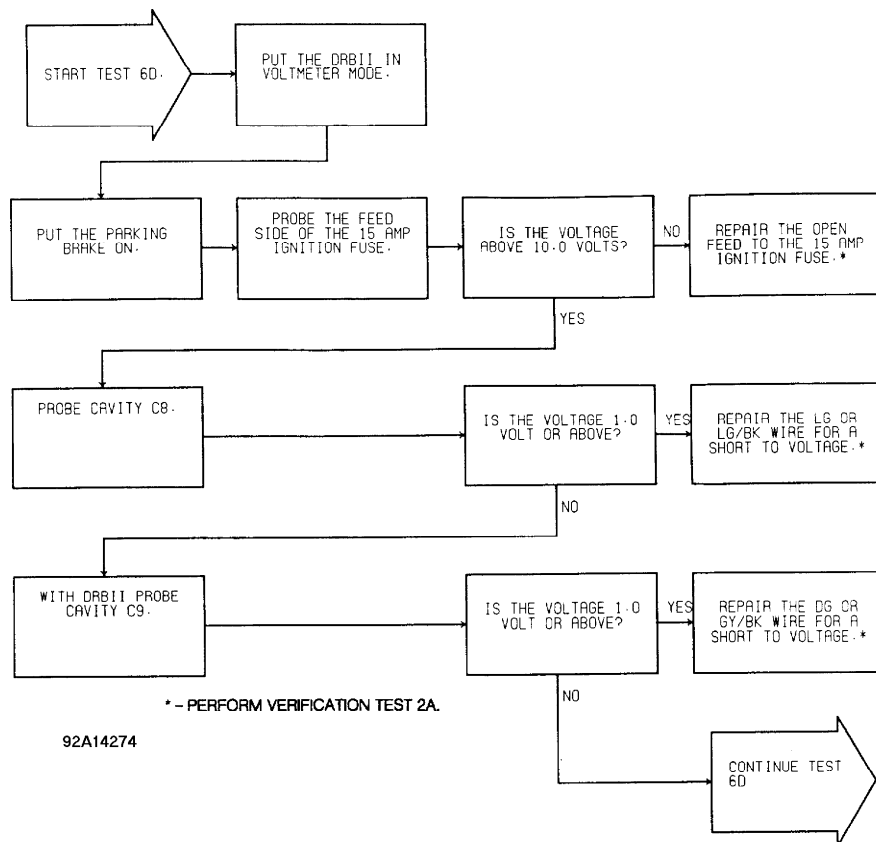


Fig. 72: Test 6D - Code 703, Flow Chart (1 of 3)

### MJ and XJ Bodies

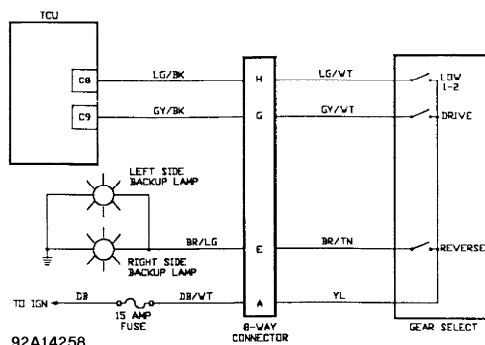


Fig. 73: Test 6D - Gear Select Switch Schematic (Cherokee)

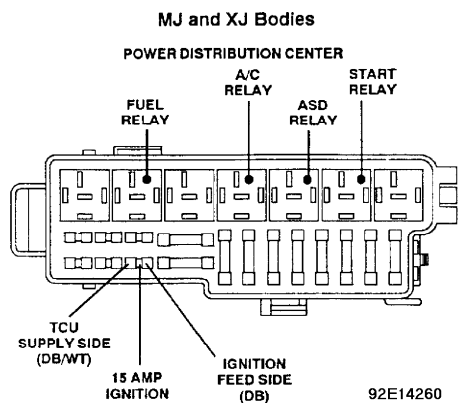


Fig. 74: Test 6D - Location of Gear Select Switch Fuse (Cherokee)

## XJ BODY

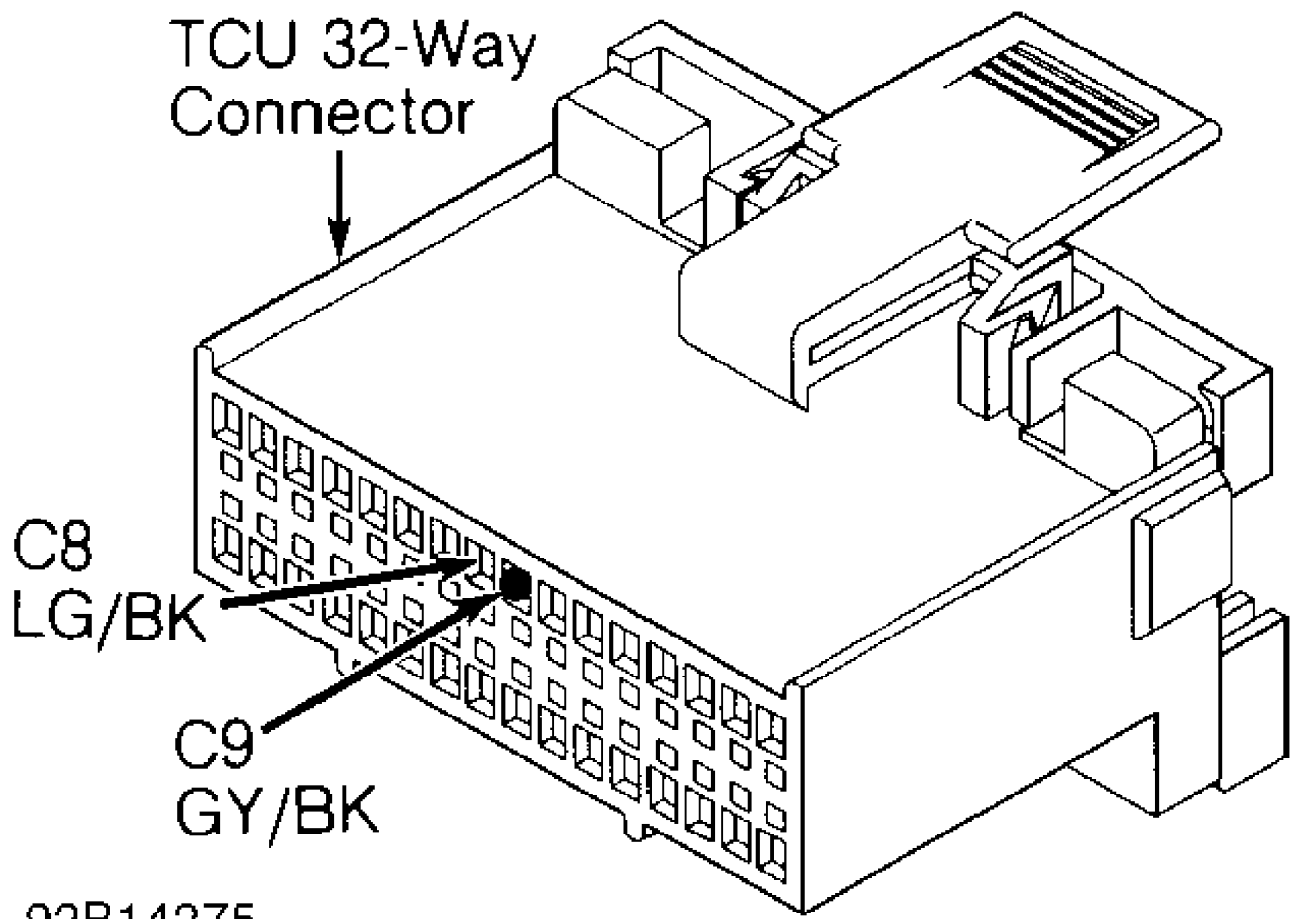
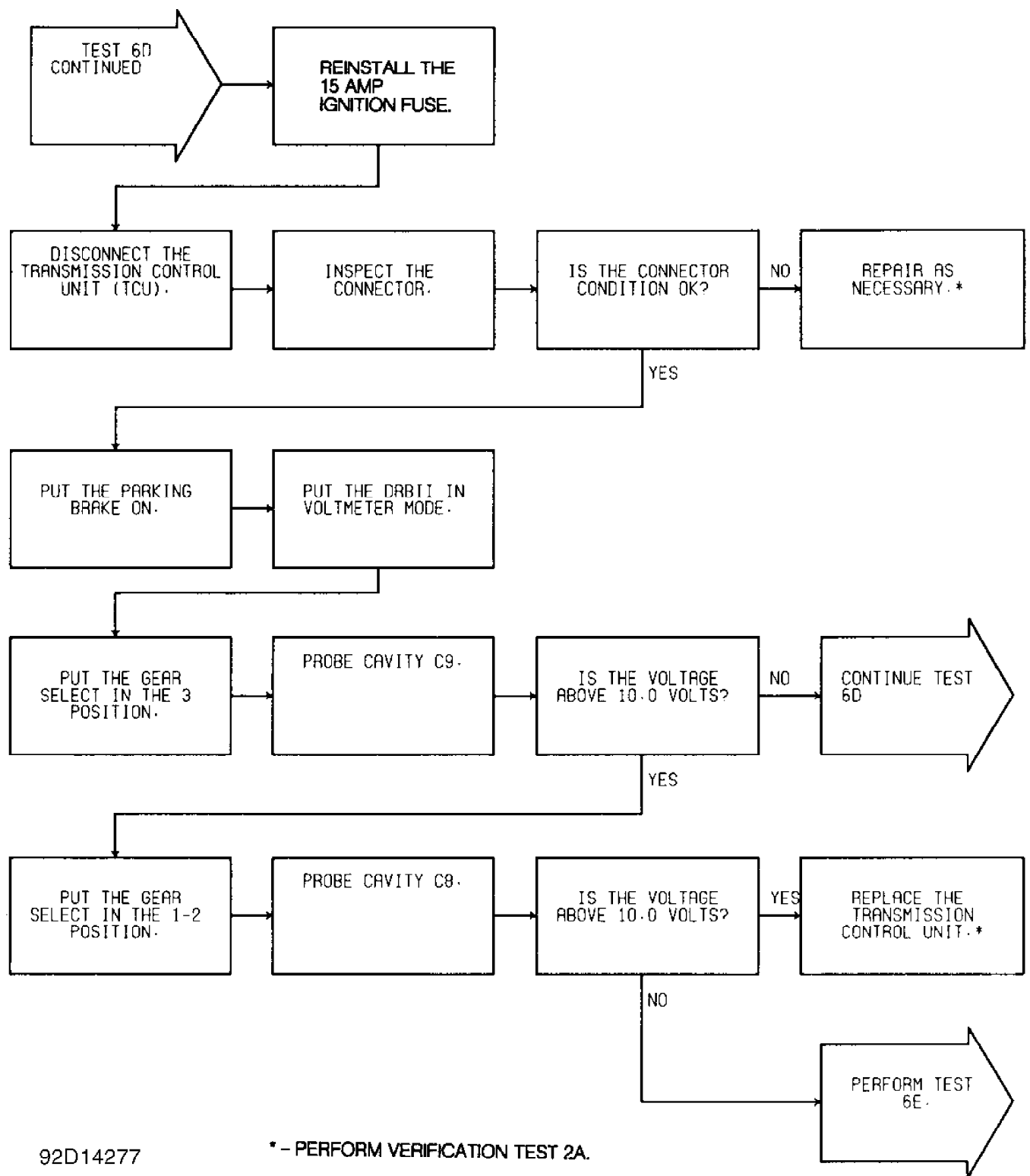


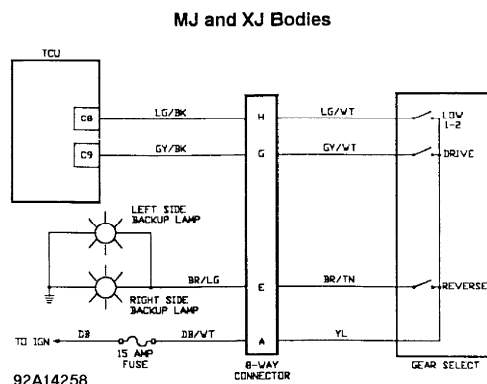
Fig. 75: Test 6D - TCU 32-Way Connector (Cavities 8 & 9, Cherokee)





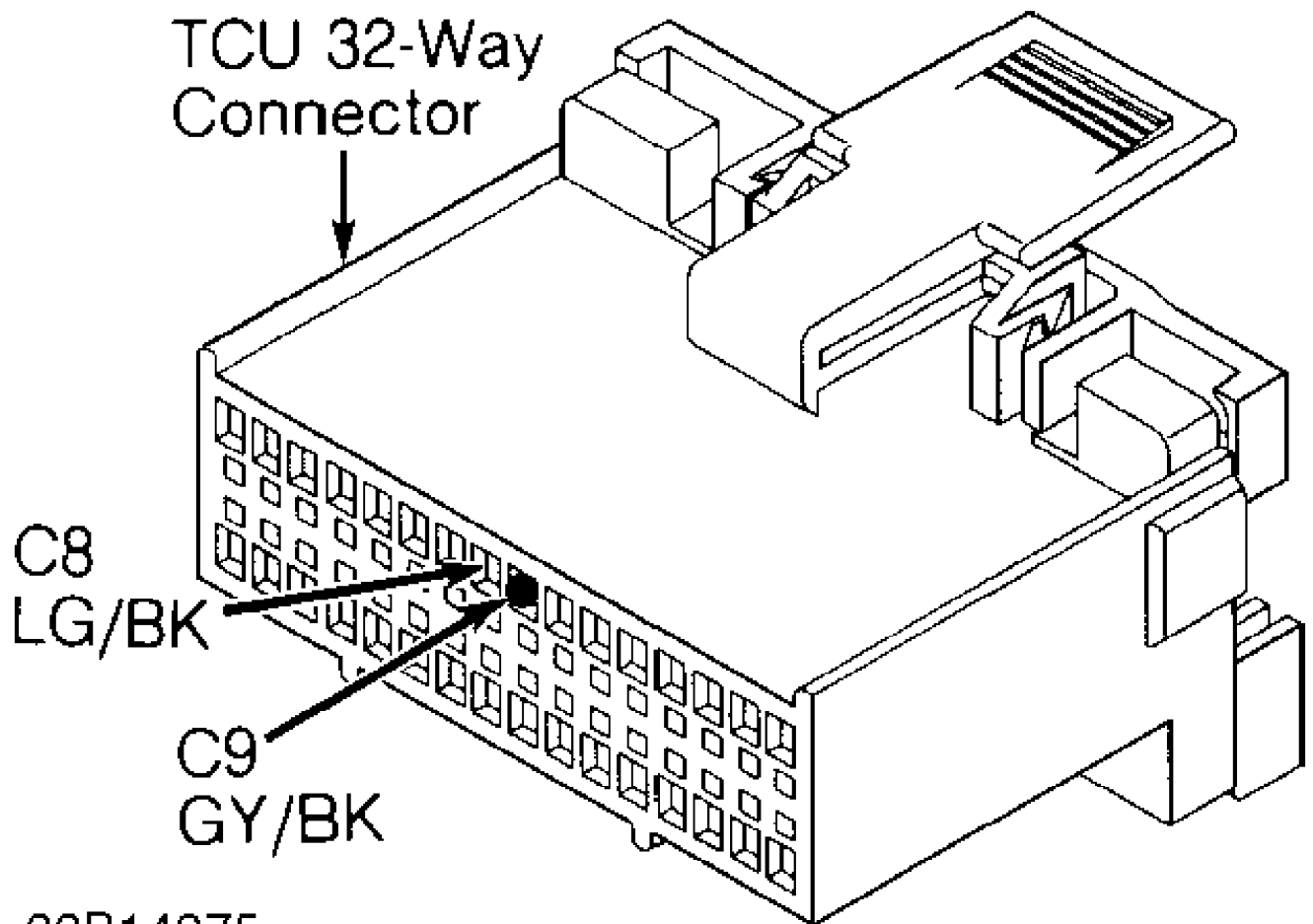
92D14277

Fig. 76: Test 6D - Code 703, Flow Chart (2 of 3)



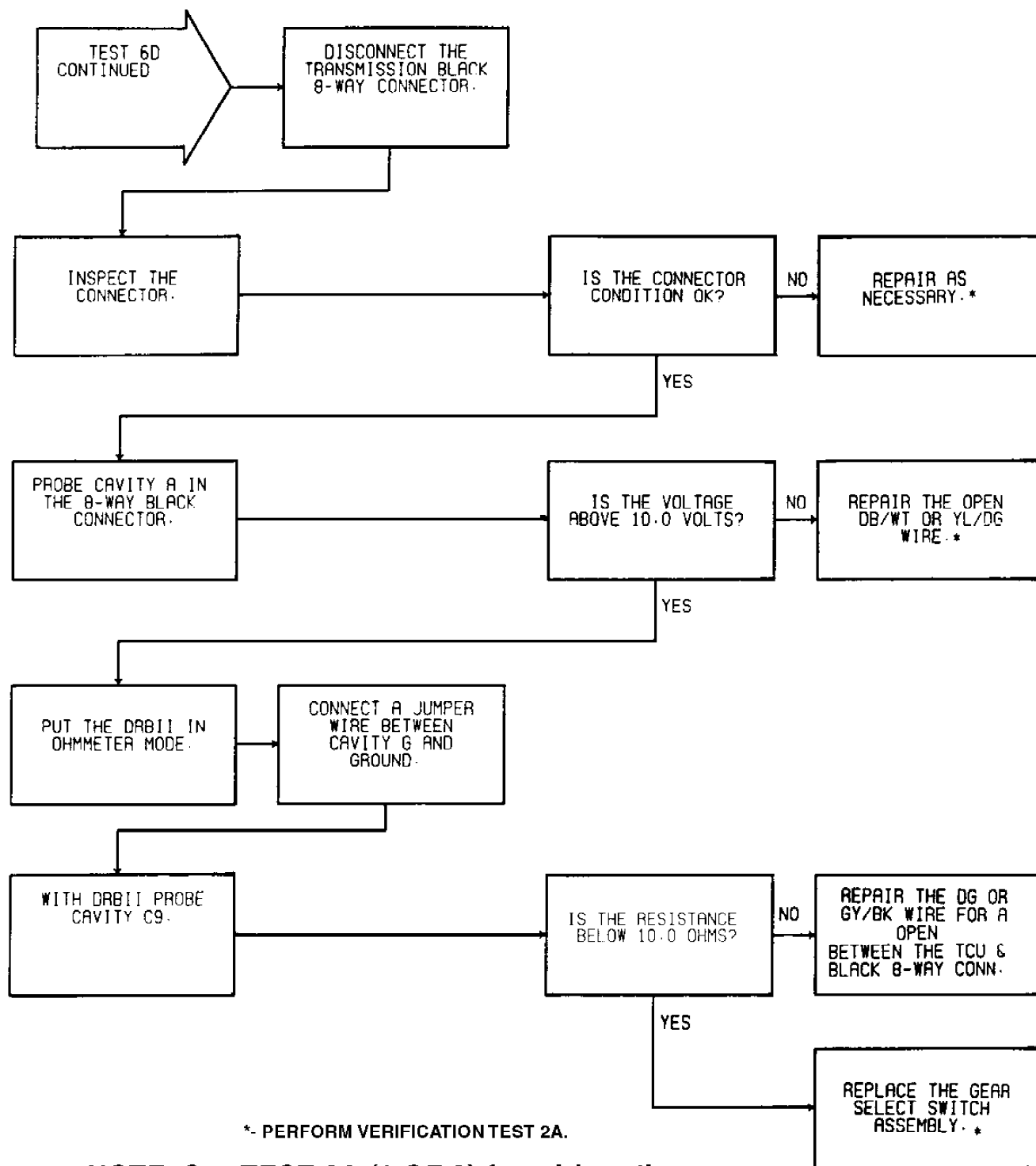
92A14258  
Fig. 77: Test 6D - Gear Select Switch Schematic (Cherokee)

## XJ BODY



92B14275

Fig. 78: Test 6D - TCU 32-Way Connector (Cavities 8 & 9, Cherokee)



**NOTE: See TEST 6A (1 OF 2) for wiring diagram.**

92E14278

Fig. 79: Test 6D - Code 703, Flow Chart (3 of 3)

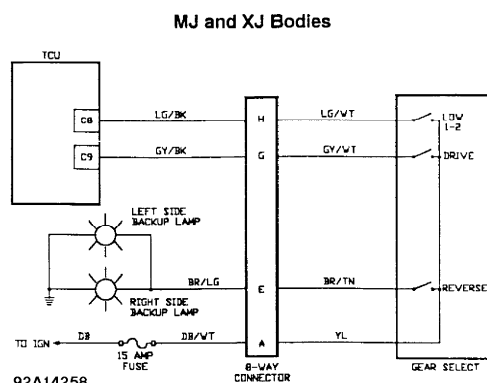


Fig. 80: Test 6D - Gear Select Switch Schematic (Cherokee)

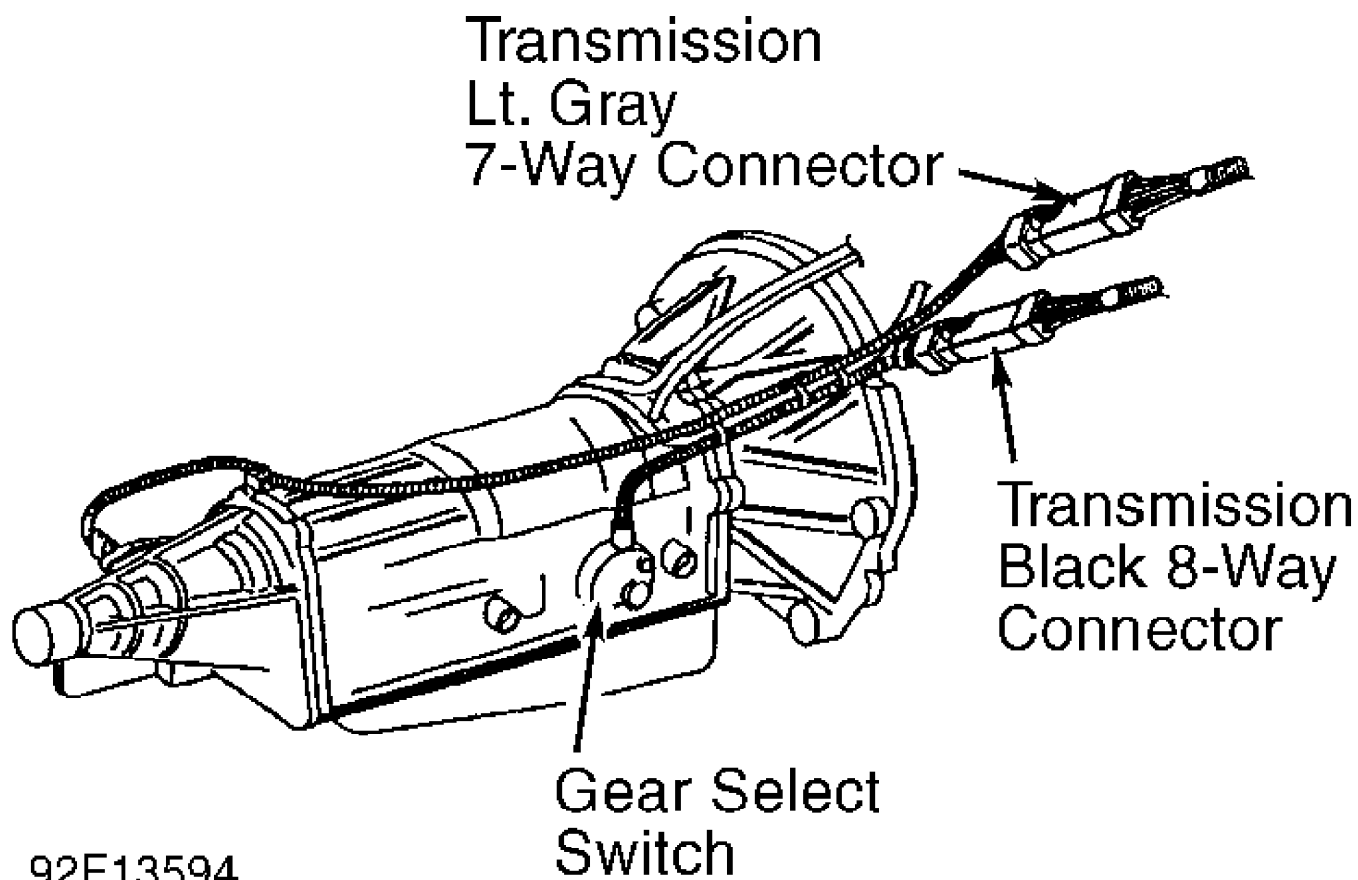


Fig. 81: Test 6D - Code 703, Location of Gear Select Switch

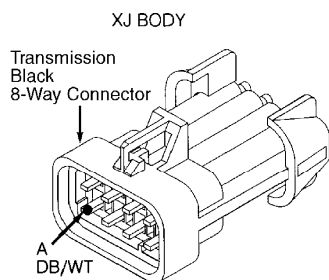
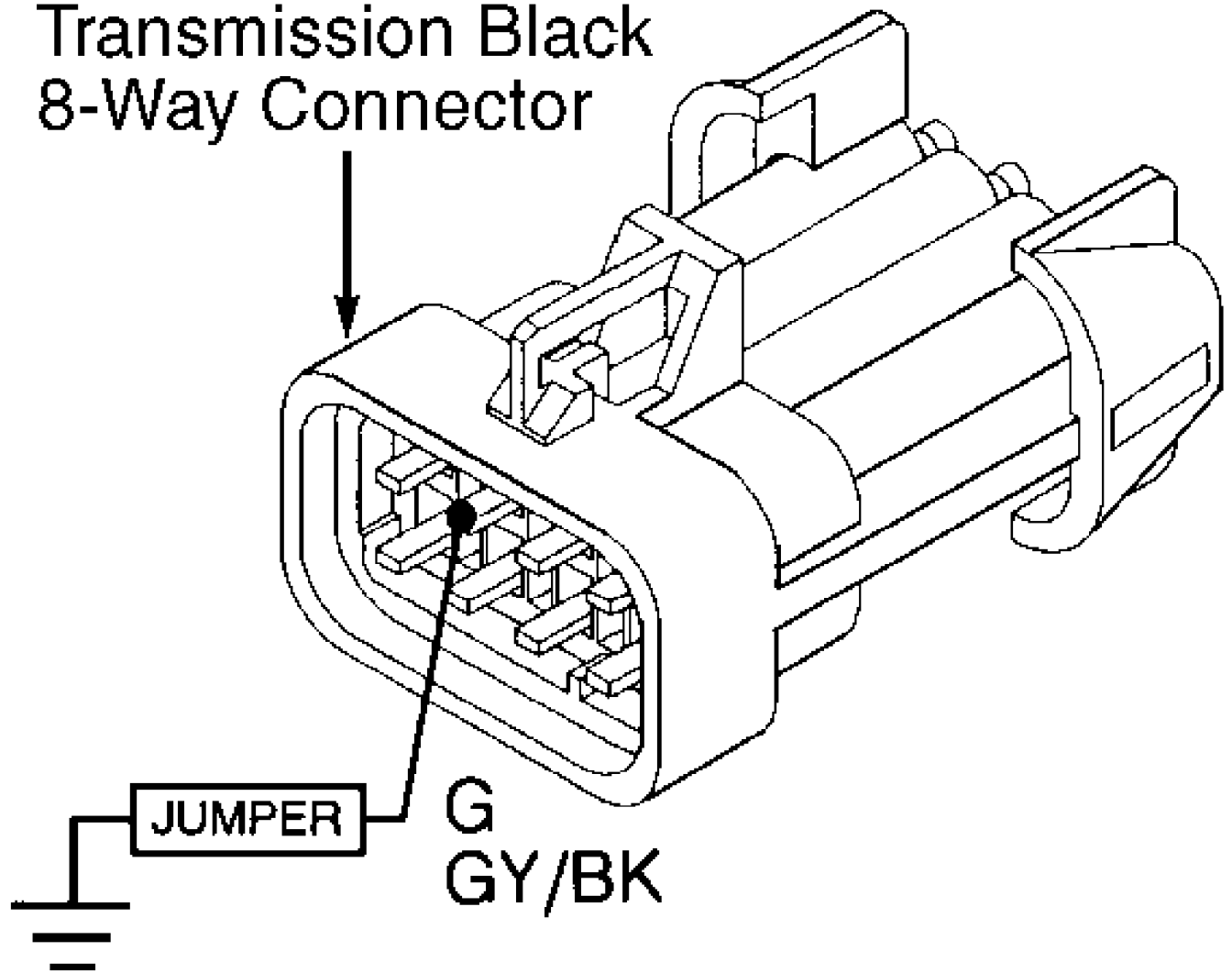


Fig. 82: Test 6D - 8-Way Black Connector Cavity "A" (Cherokee)

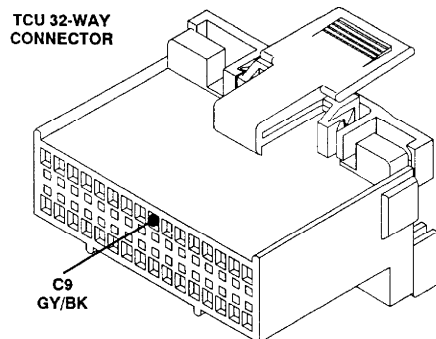
XJ BODY

Transmission Black  
8-Way Connector



92F14279

Fig. 83: Test 6D - 8-Way Black Connector Cavity "G" (Cherokee)



ZJ Body: DG

92I14264

Fig. 84: Test 6D - Code 703, TCU 32-Way Connector (Cavity 9)

## TEST 6E - CODE 703 - GEAR SELECT SWITCH CIRCUIT

NOTE: Perform TEST 6D - CODE 703 - GEAR SELECT SWITCH CIRCUIT before proceeding.

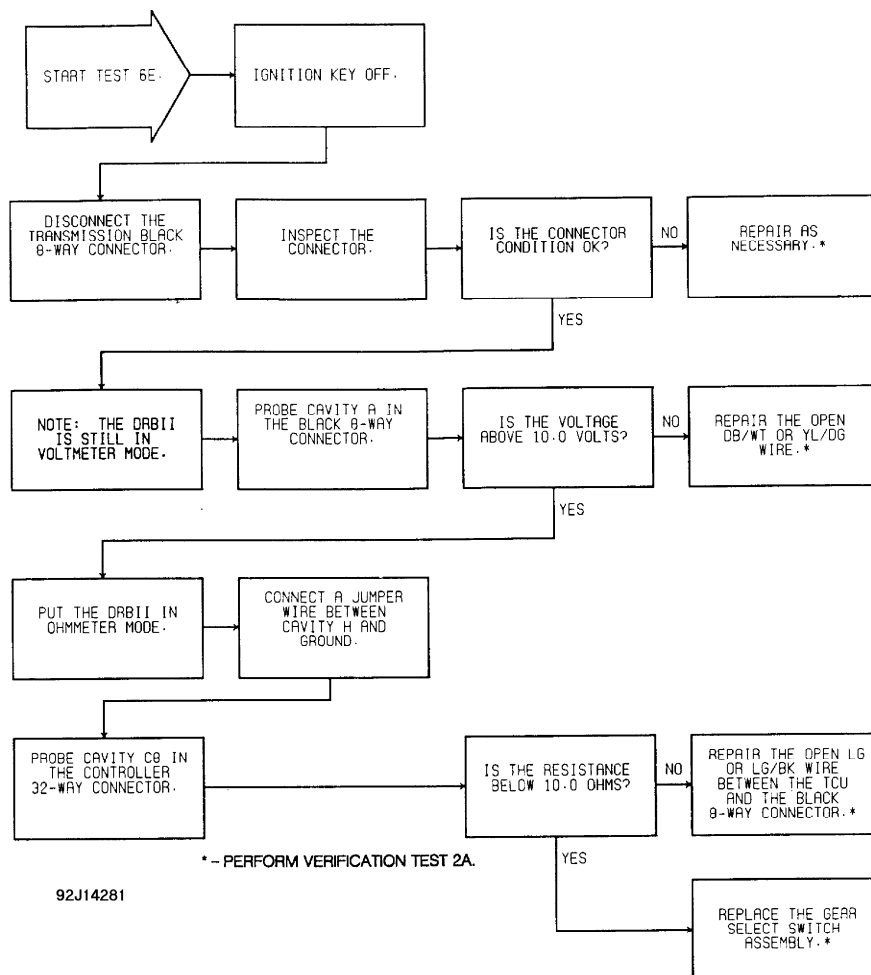
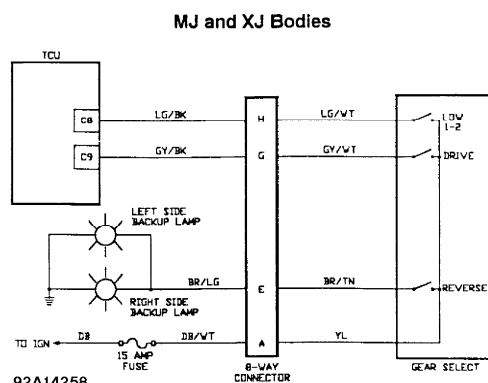
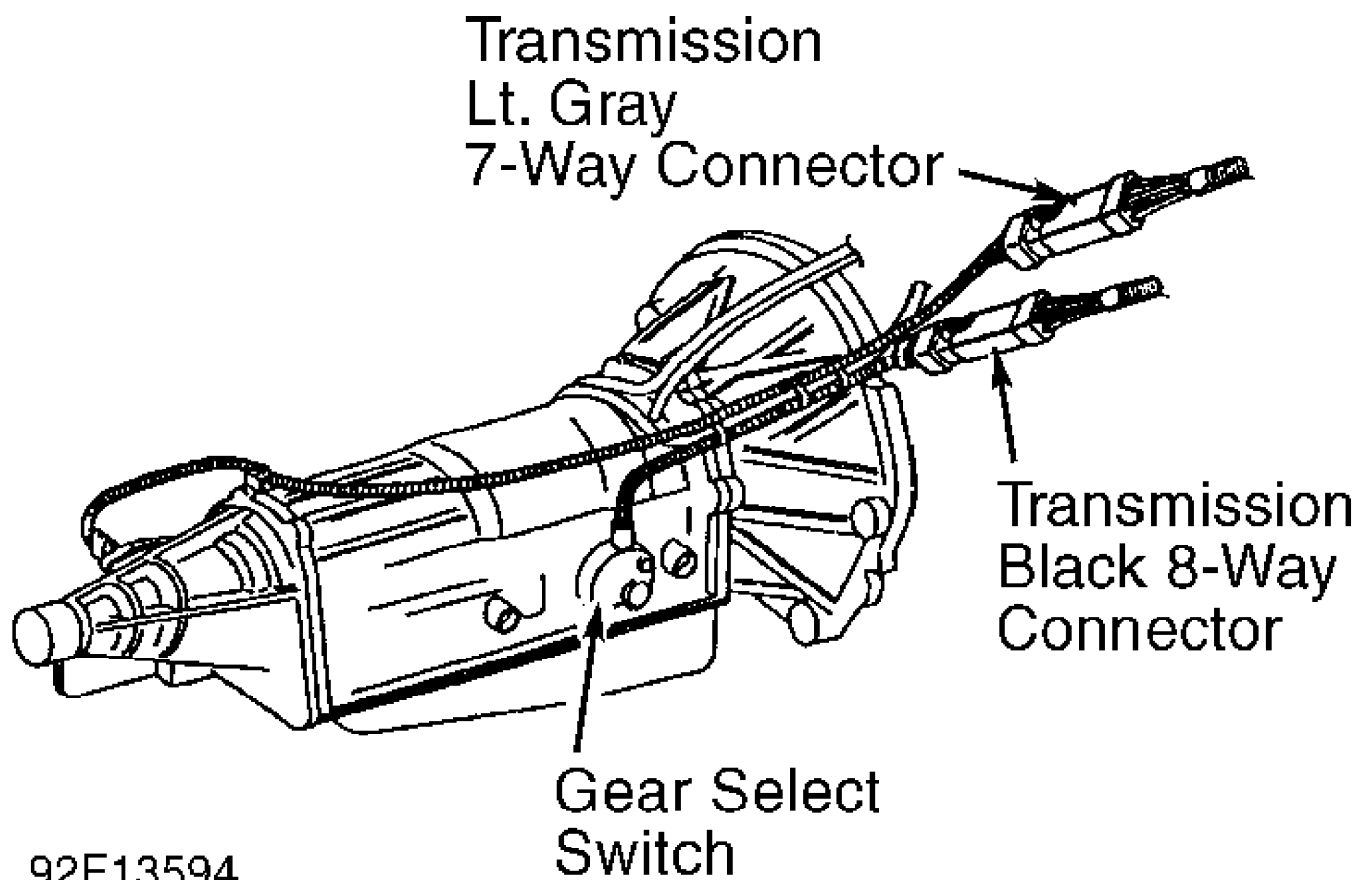


Fig. 85: Test 6E - Code 703, Flow Chart



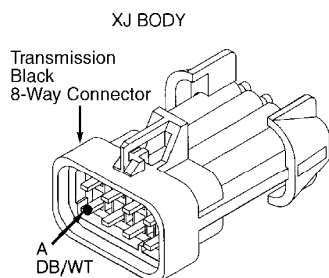
92A14258

Fig. 86: Test 6E - Gear Select Switch Schematic (Cherokee)



**92F13594**

Fig. 87: Test 6E - Code 703, Location of Gear Select Switch



92A14266

Fig. 88: Test 6E - 8-Way Black Connector Cavity "A" (Cherokee)

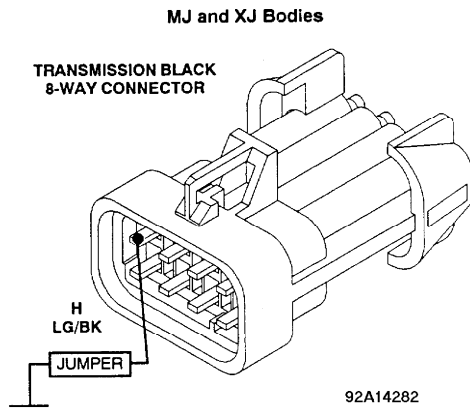


Fig. 89: Test 6E - 8-Way Black Connector Cavity "H" (Cherokee)

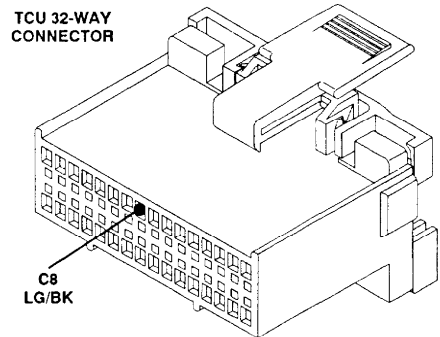


Fig. 90: Test 6E - TCU 32-Way Connector (Cavity 8)

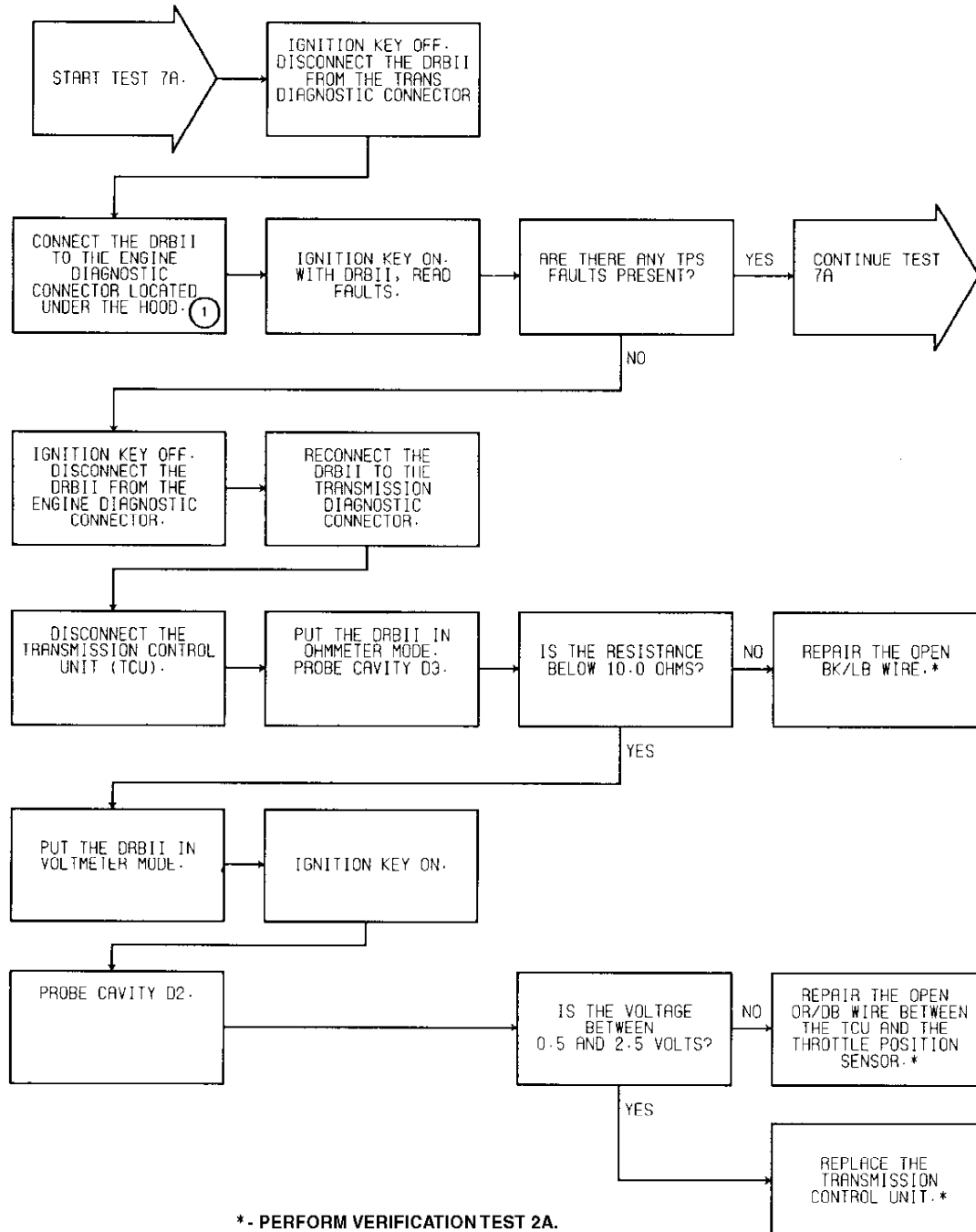
## TEST 7A - CODE 705 - TPS CIRCUIT

**NOTE:** Perform TEST 1A - VERIFICATION OF COMPLAINT before proceeding.

**NOTE:** On Cherokee, engine diagnostic connector is located at left side of engine compartment, near engine controller. Engine diagnostic connector is a 6-terminal connector.

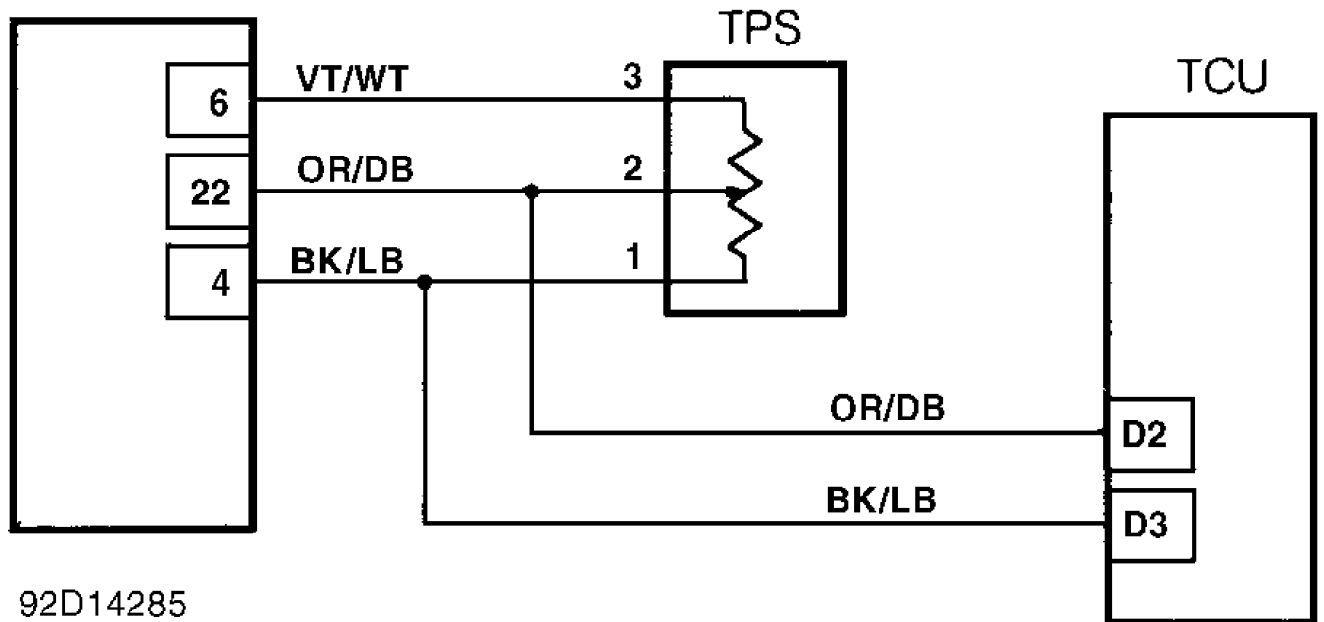


**Perform TEST 6D before proceeding.**



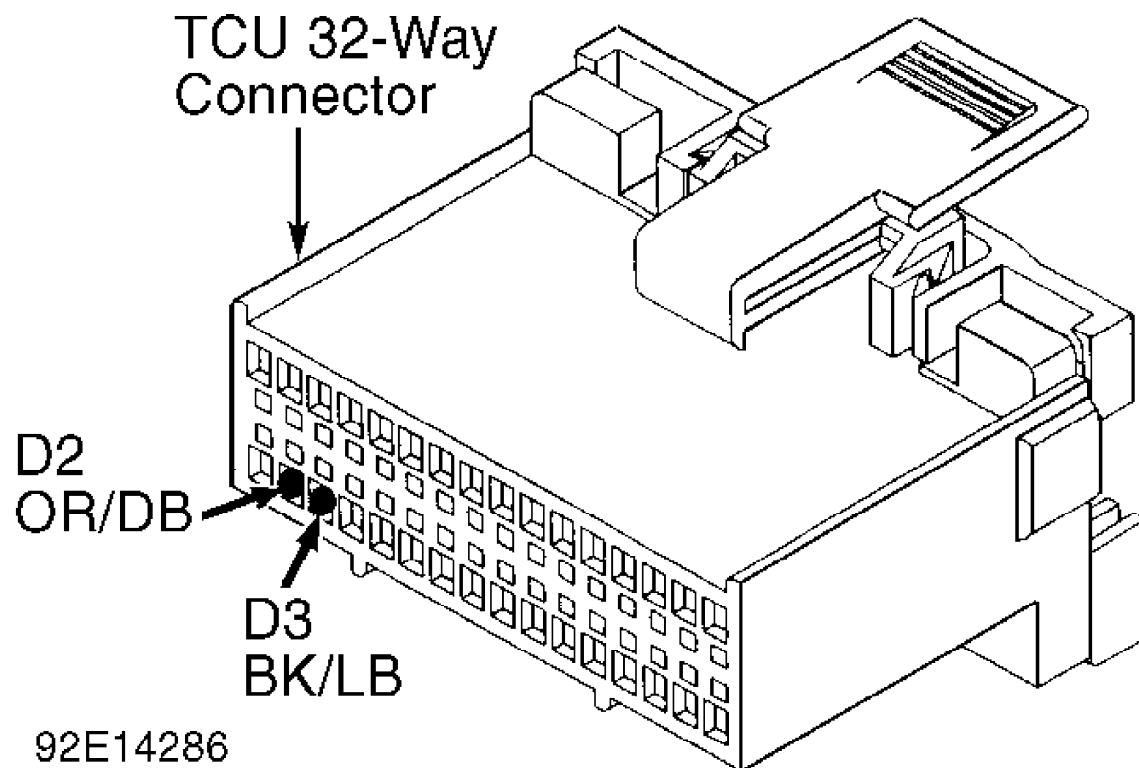
① - On XJ models, engine diagnostic connector is located at left side of engine compartment, near engine controller.

## ENGINE CONTROLLER



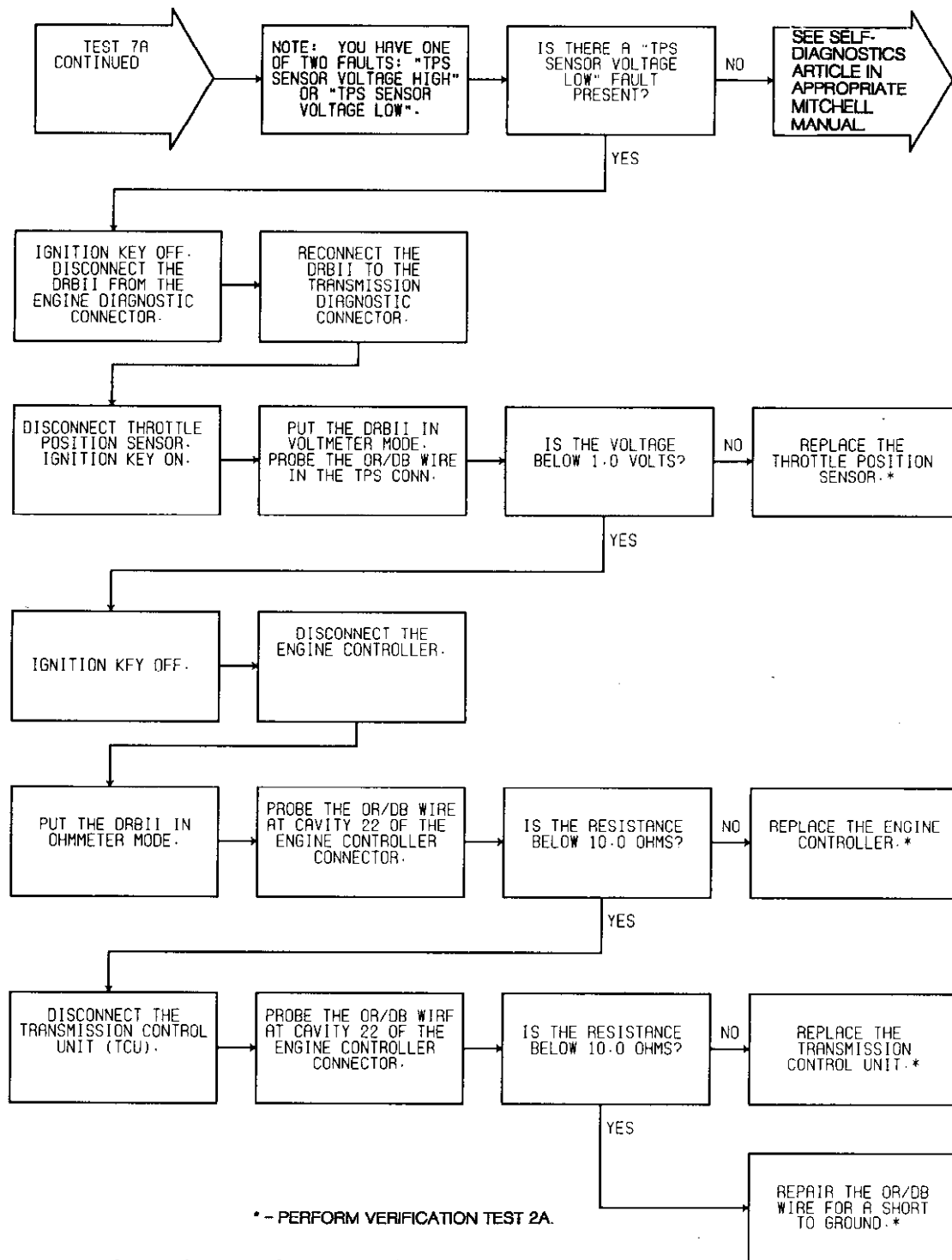
92D14285

Fig. 92: Test 7A - Code 705, Schematic



92E14286

Fig. 93: Test 7A - TCU 32-Way Connector (Cavities D2 & D3)

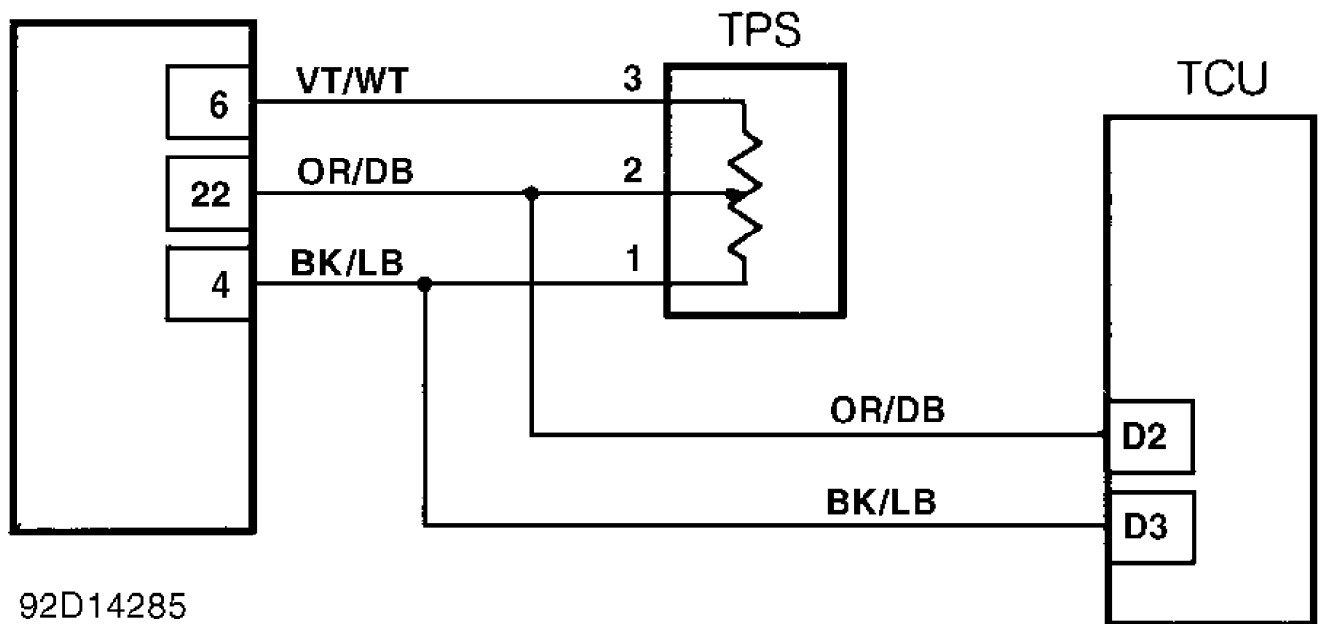


**NOTE: See TEST 7A (1 OF 2) for wiring diagram.**

92F14287

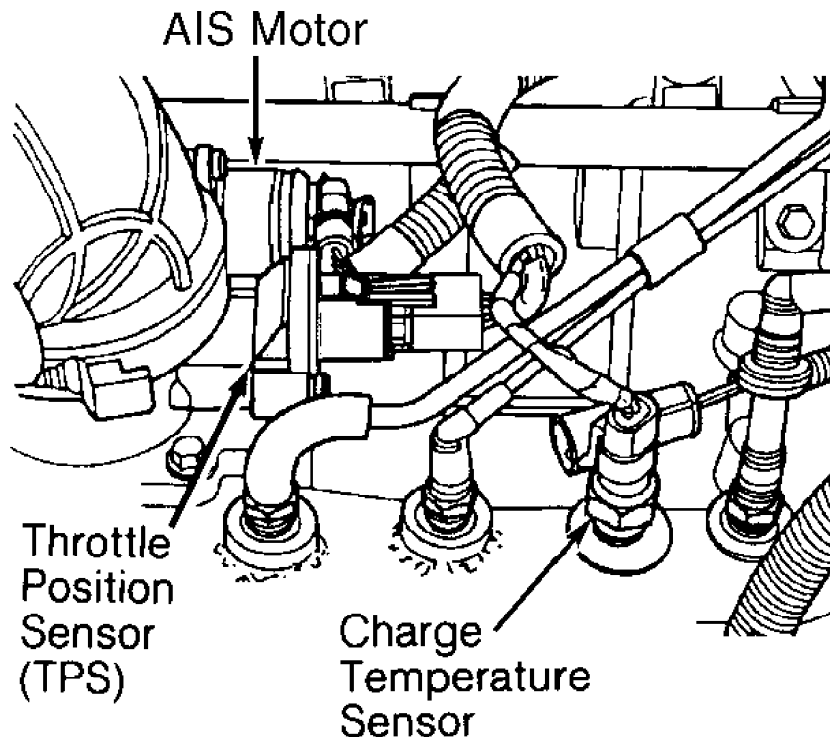
Fig. 94: Test 7A - Code 705, Flow Chart (2 of 2)

## ENGINE CONTROLLER



92D14285

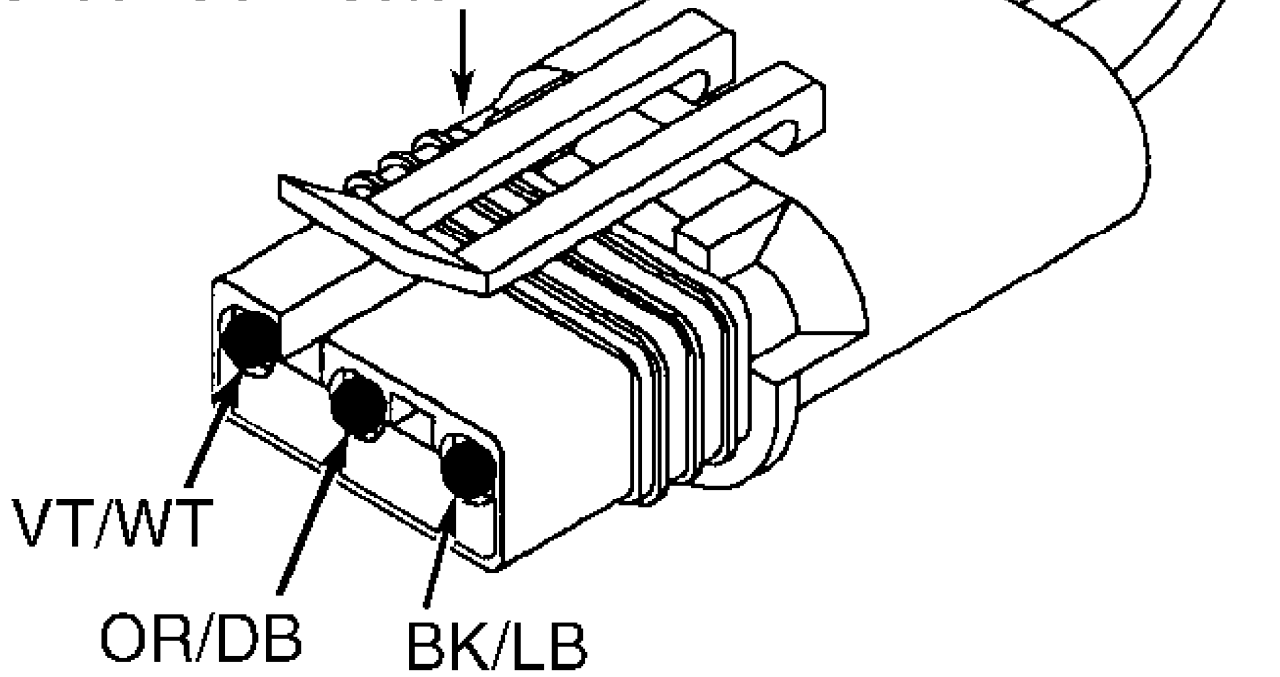
Fig. 95: Test 7A - Code 705, Schematic



92G14288

Fig. 96: Test 7A - Location of Throttle Position Sensor (TPS)

## Throttle Position Sensor Connector

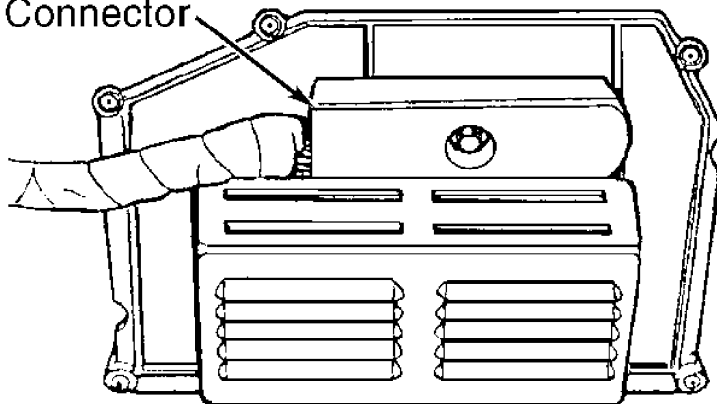


92H14289

Fig. 97: Test 7A - Code 705, View of TPS Connector

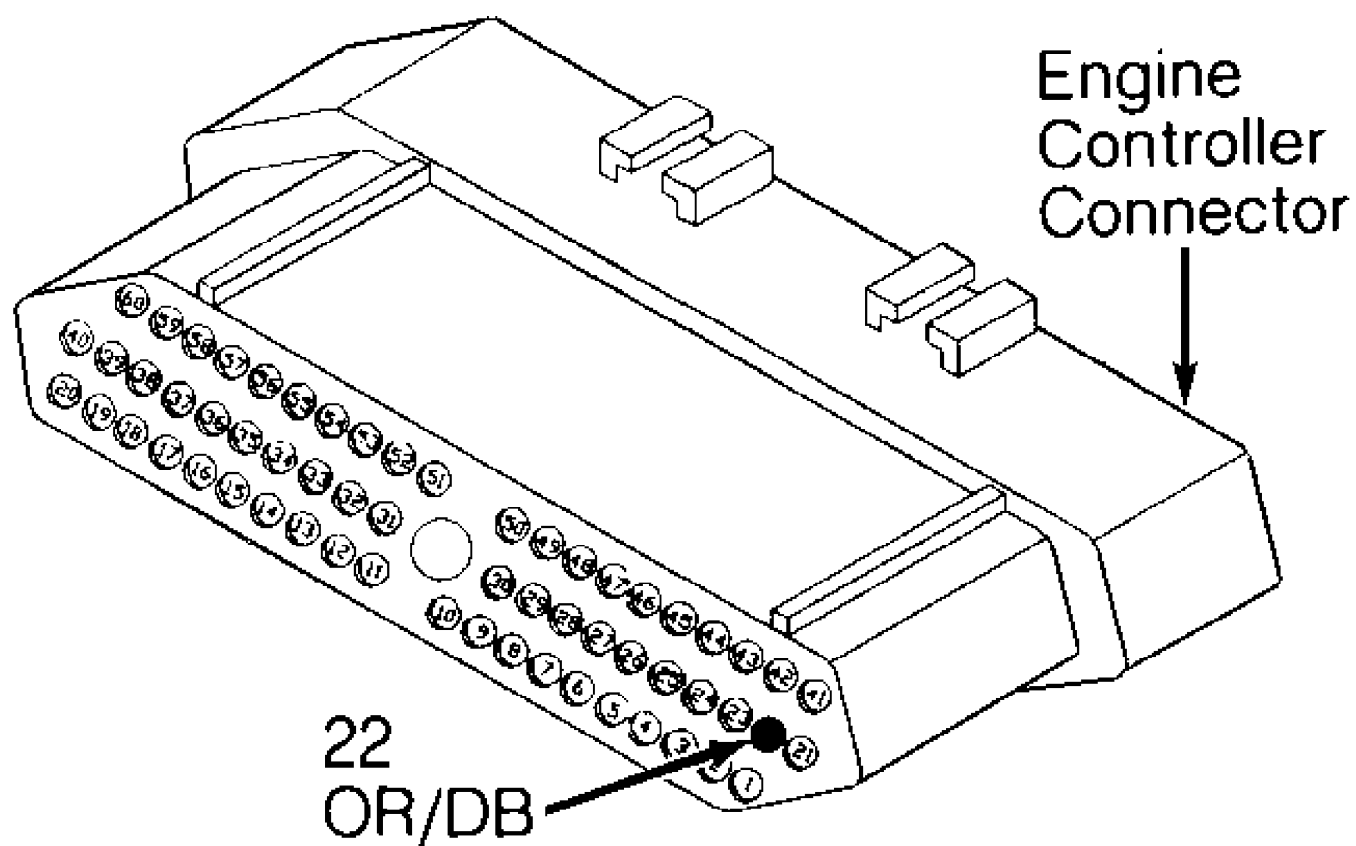
XJ BODY

## Engine Controller Connector



92A14290

Fig. 98: Test 7A - Location of Engine Control Connector (Cherokee)



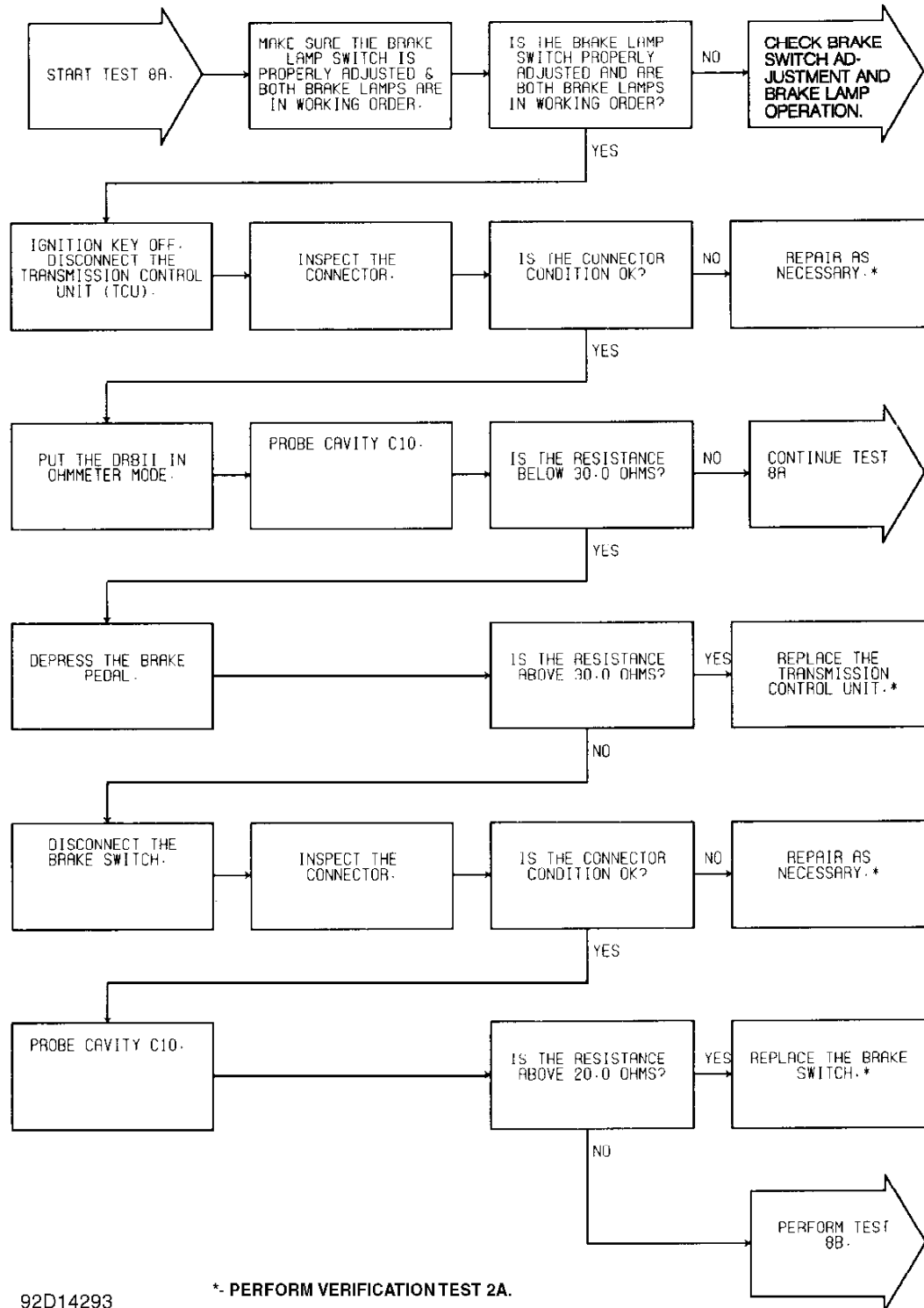
92C14292

Fig. 99: Test 7A - View of Engine Control Connector (Cavity 22)

#### TEST 8A - CODE 706 - BRAKE SWITCH CIRCUIT

NOTE: Perform TEST 1A - VERIFICATION OF COMPLAINT before proceeding.

Perform TEST 1A before proceeding.



92D14293

\*- PERFORM VERIFICATION TEST 2A.

Fig. 100: Test 8A - Code 706, Flow Chart

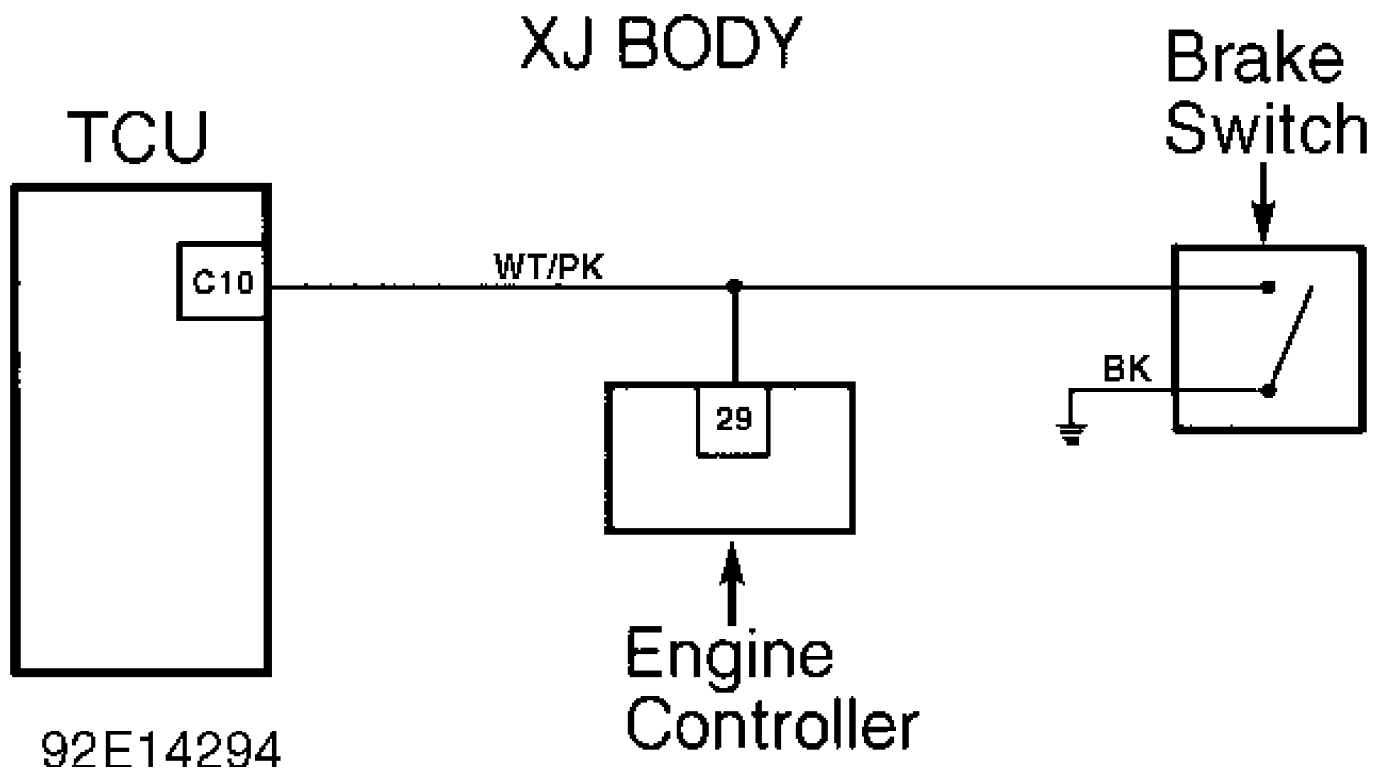


Fig. 101: Test 8A - Code 706, Schematic (Cherokee)

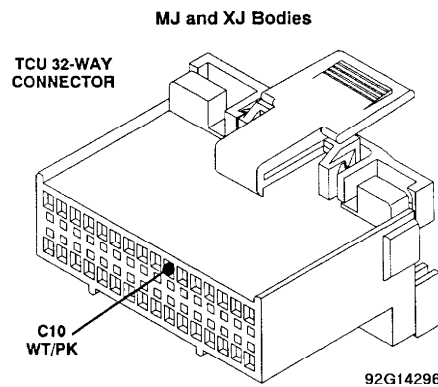


Fig. 102: Test 8A - TCU 32-Way Connector (Cavity 10, Cherokee)

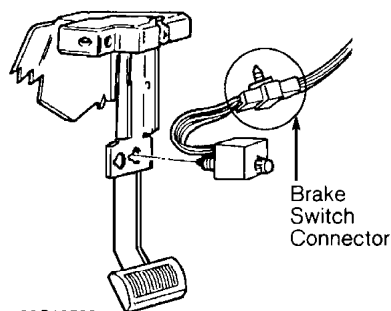


Fig. 103: Test 8A - Location of Brake Switch Connector



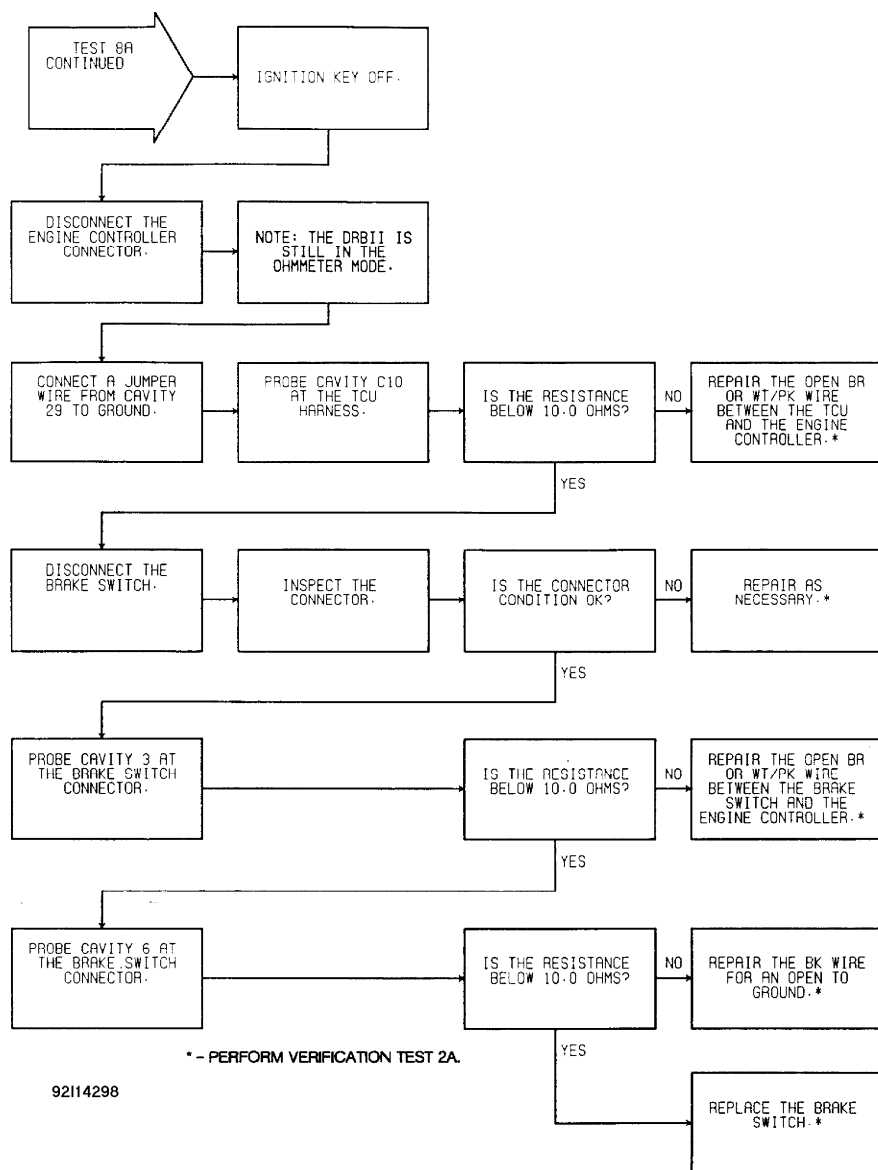


Fig. 104: Test 8A - Code 706, Flow Chart

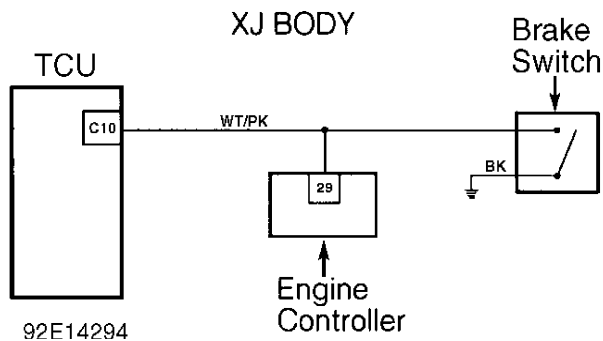


Fig. 105: Test 8A - Code 706, Schematic (Cherokee)

**MJ and XJ Bodies**  
**ENGINE CONTROLLER CONNECTOR**

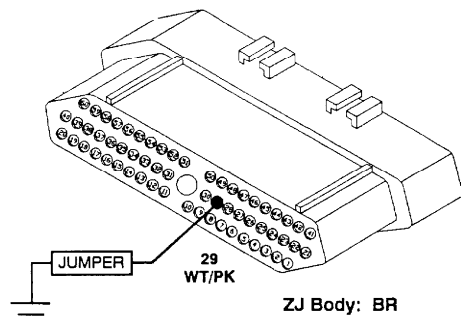


Fig. 106: Test 8A - View of Engine Controller Connector (Cavity 29)

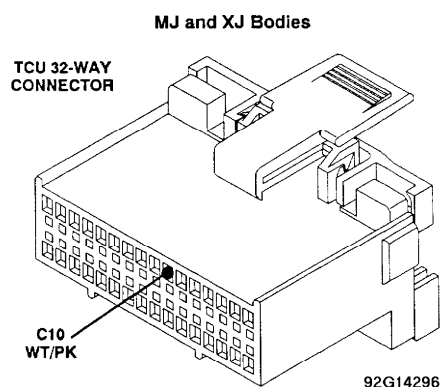
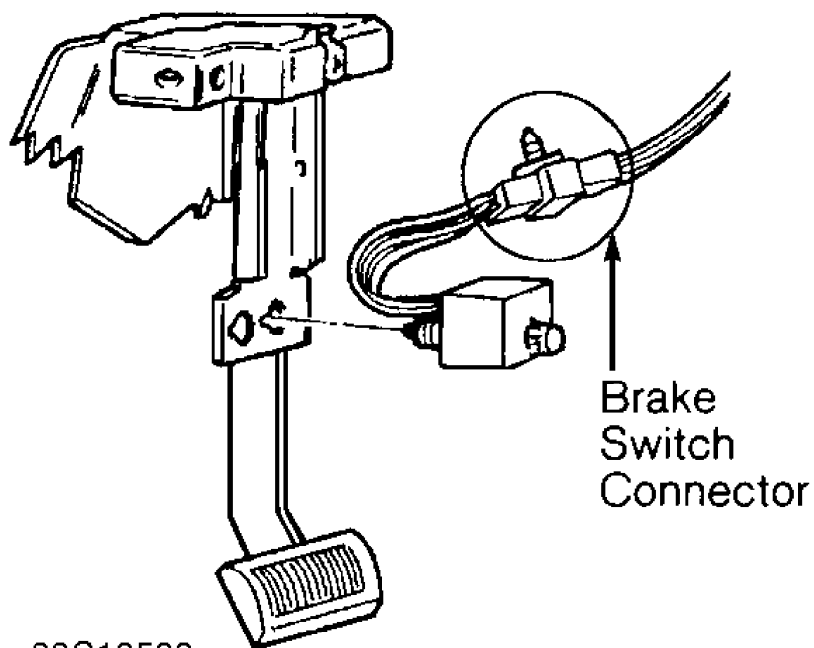


Fig. 107: Test 8A - TCU 32-Way Connector (Cavity 10, Cherokee)



92C13583

Fig. 108: Test 8A - Location of Brake Switch Connector

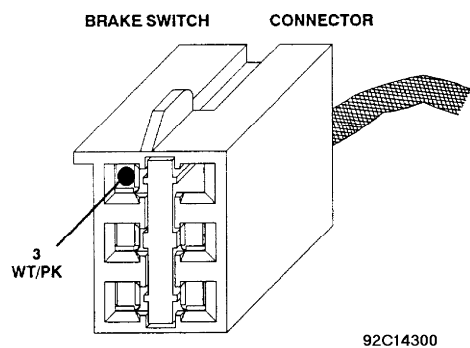


Fig. 109: Test 8A - View of Brake Switch Connector (Cavity 3)

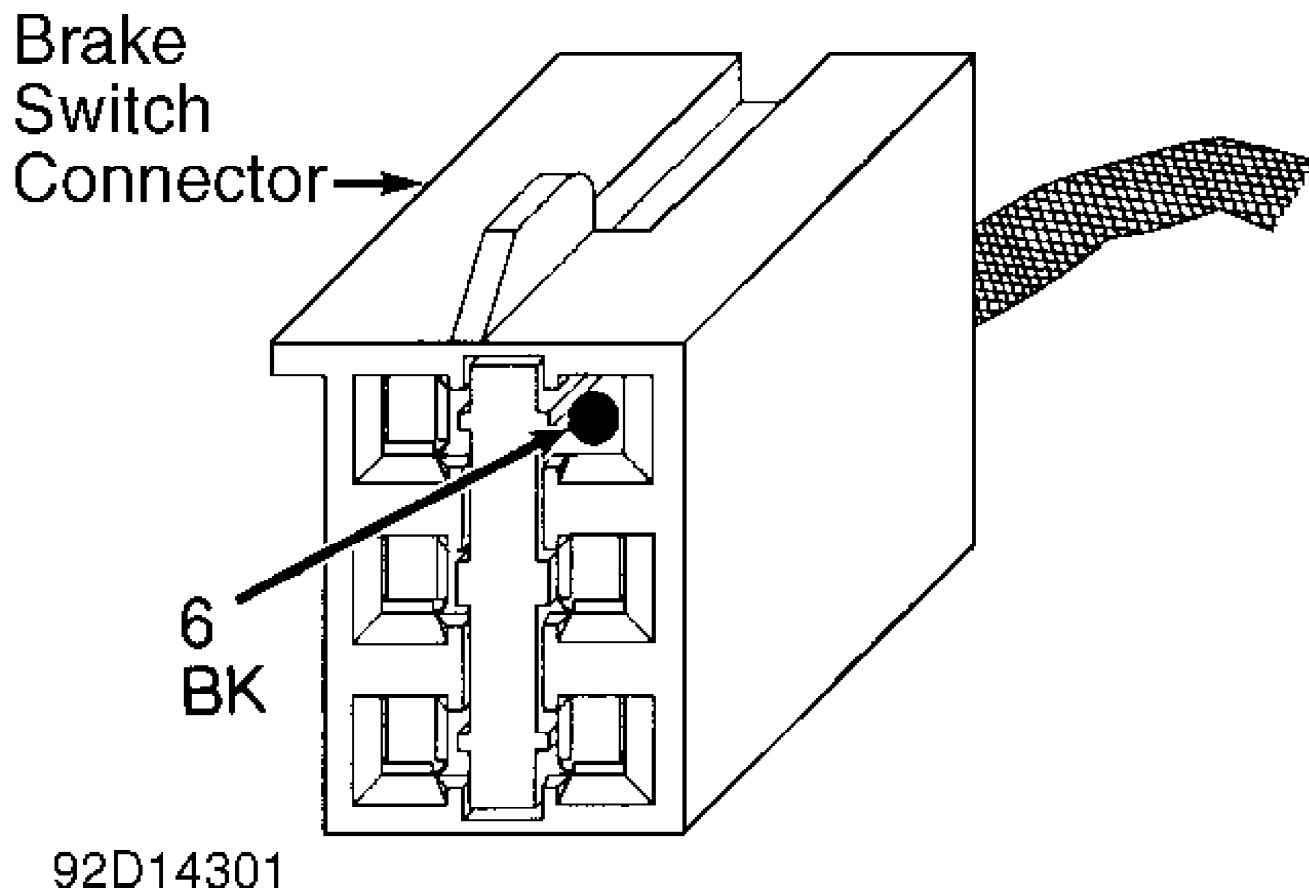
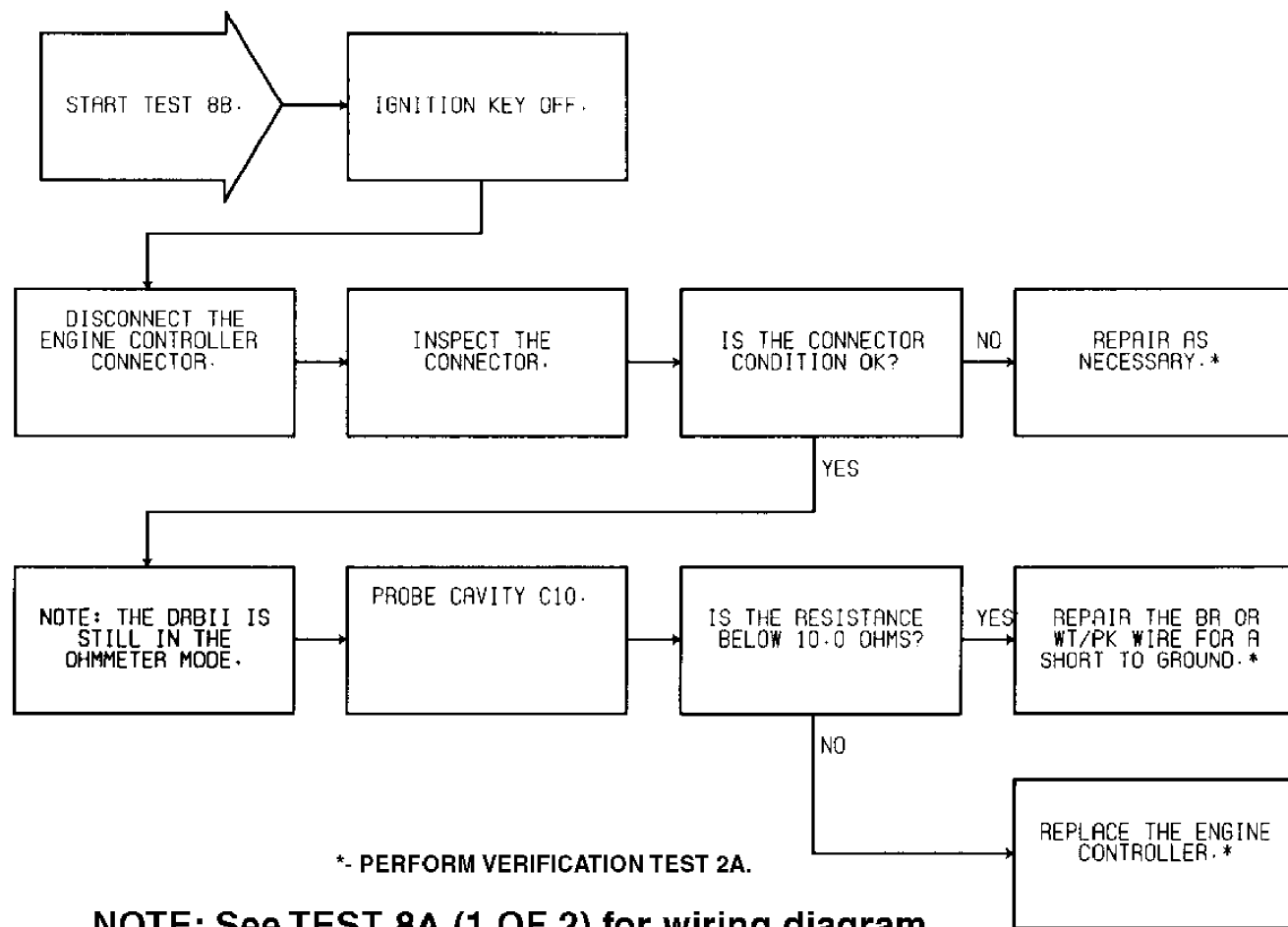


Fig. 110: Test 8A - View of Brake Switch Connector (Cavity 6)

### TEST 8B - CODE 706 - BRAKE SWITCH CIRCUIT

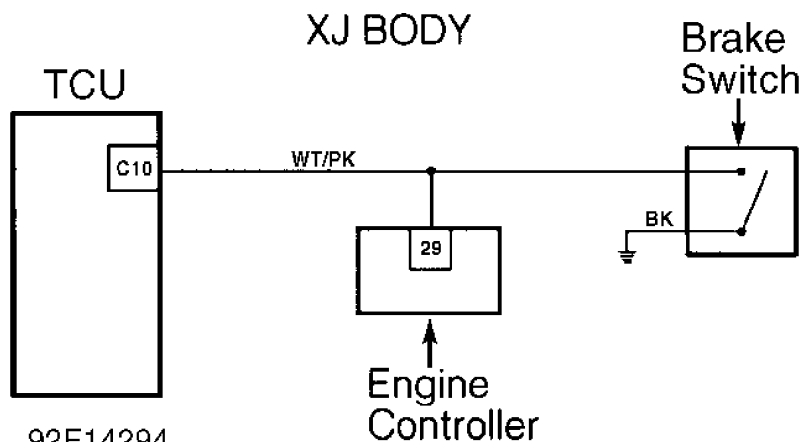
NOTE: Perform TEST 8A - CODE 706 - BRAKE SWITCH CIRCUIT before proceeding.

**Perform TEST 8A before proceeding.**



92E14302

Fig. 111: Test 8B - Code 706, Flow Chart

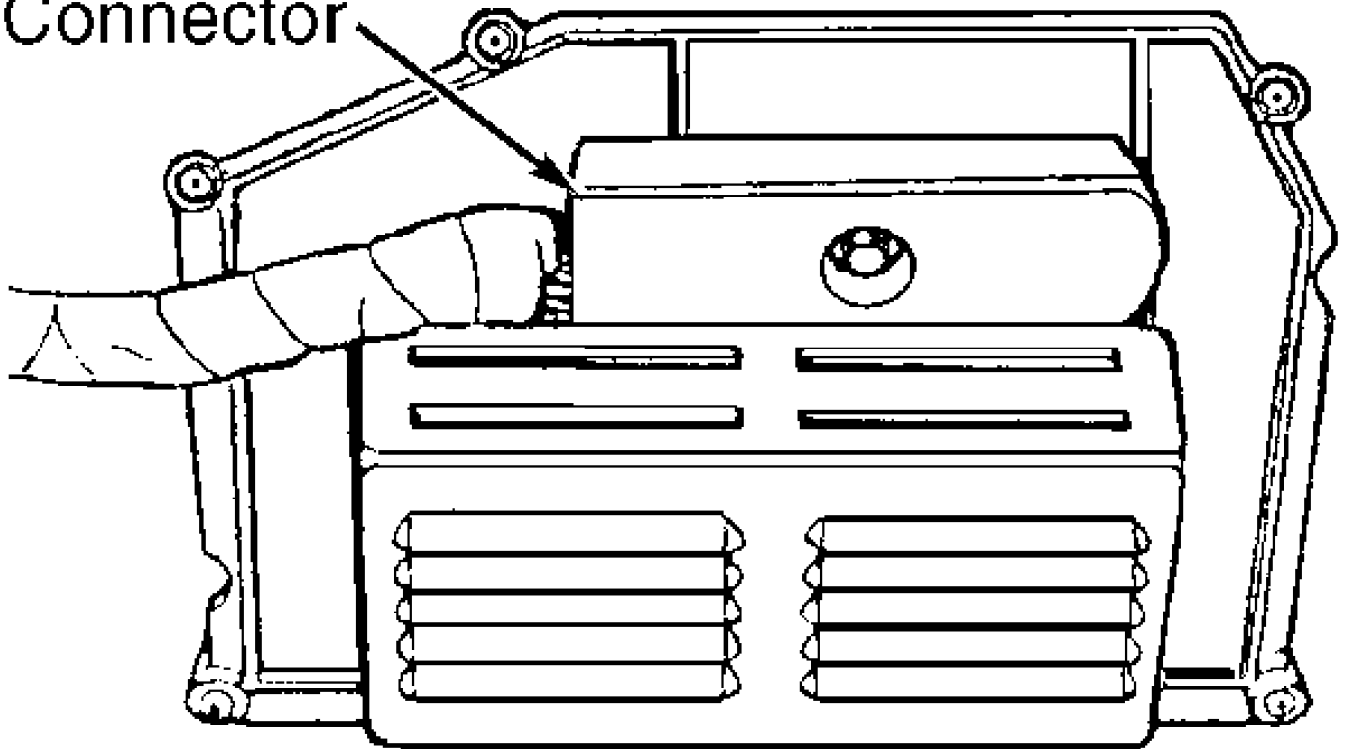


92E14294

Fig. 112: Test 8B - Code 706, Schematic (Cherokee)

# XJ BODY

## Engine Controller Connector



92A14290

Fig. 113: Test 7A - Location of Engine Control Connector (Cherokee)

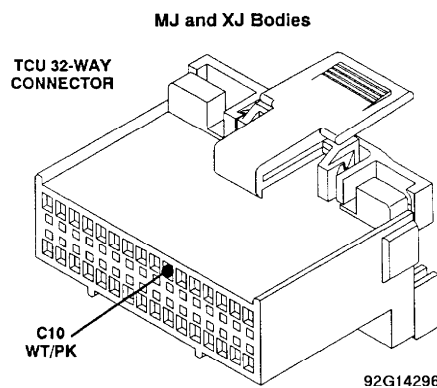


Fig. 114: Test 8B - TCU 32-Way Connector (Cavity 10, Cherokee)

### TEST 9A - WRONG TCU

NOTE: Perform TEST 1A - VERIFICATION OF COMPLAINT before proceeding.

NOTE: The AW-4 is used only on 4.0L. In earlier years, it was

used with 2.5.L

The DRB-II has determined that the wrong Transmission Control Unit (TCU) has been installed in the vehicle. There are two transmission control units available for the Jeep AW4 transmission. One is for the 4-cylinder 2.5L engine and the other is for the 6-cylinder 4.0L engine.

1) using the DRB-II, read MODULE INFO. See HELP 1 for assistance.

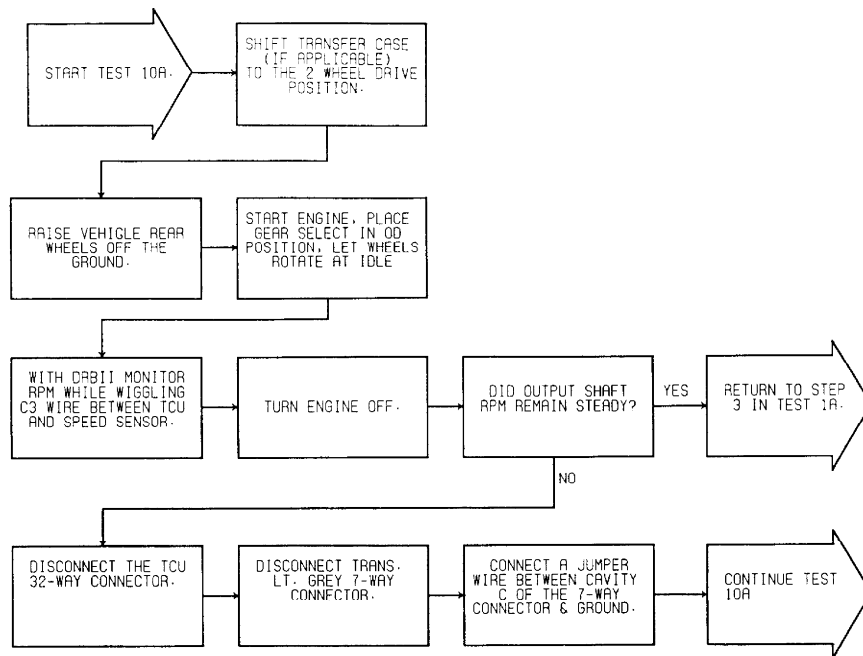
2) Determine what vehicle should be in the vehicle.

- \* 2.5L Engine: TCU 02 (Used in earlier years only)
- \* 4.0L Engine: TCU 01 (1993-94)

3) If the wrong transmission control unit is installed, the vehicle shift points will be slightly different (the 2.5L engine TCU has higher shift points).

## TEST 10A - TESTING FOR INTERMITTENT SPEED SENSOR

NOTE: Perform TEST 1A - VERIFICATION OF COMPLAINT before proceeding.



\* - PERFORM VERIFICATION TEST 2A.

92G14304

Fig. 115: Test 10A - Flow Chart (1 of 2)

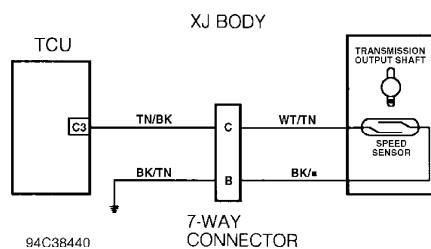


Fig. 116: Test 10A - Schematic (Cherokee)

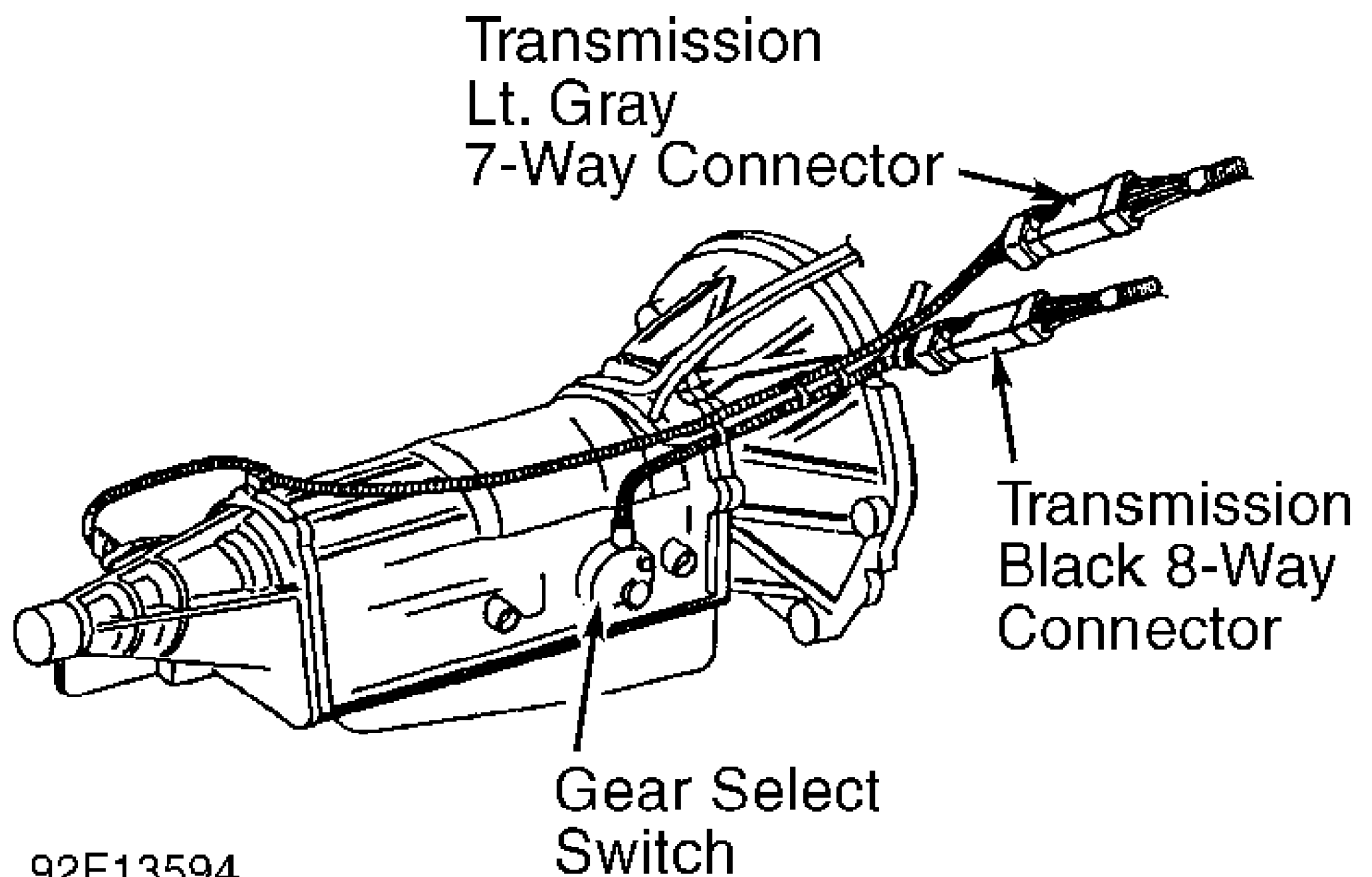
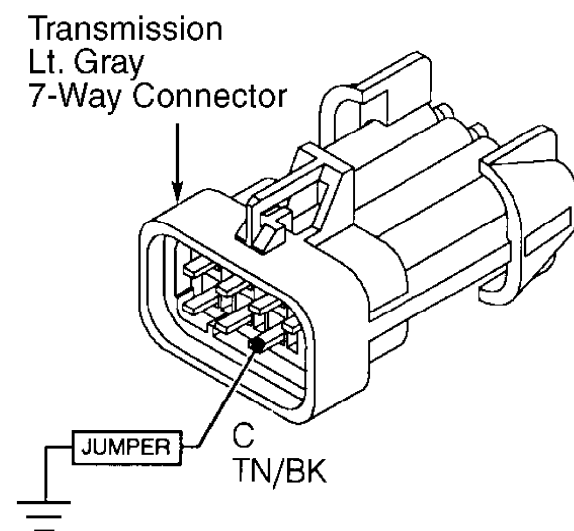


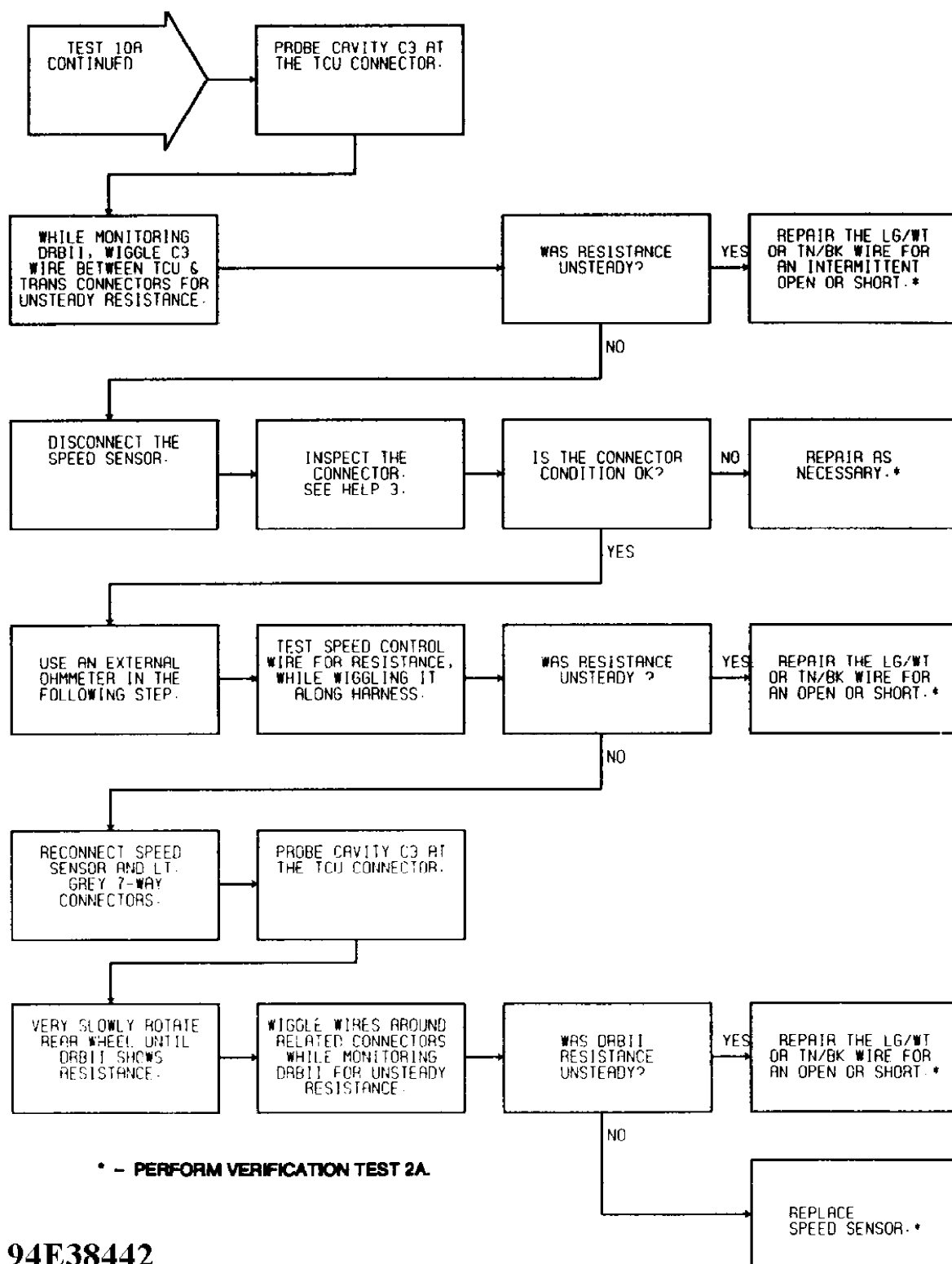
Fig. 117: Test 10A - Location of Transmission Connectors

XJ BODY



94D38441

Fig. 118: Test 10A - View of 7-Way Connector (Cherokee)



94E38442

Fig. 119: Test 10A - Flow Chart (2 of 2)



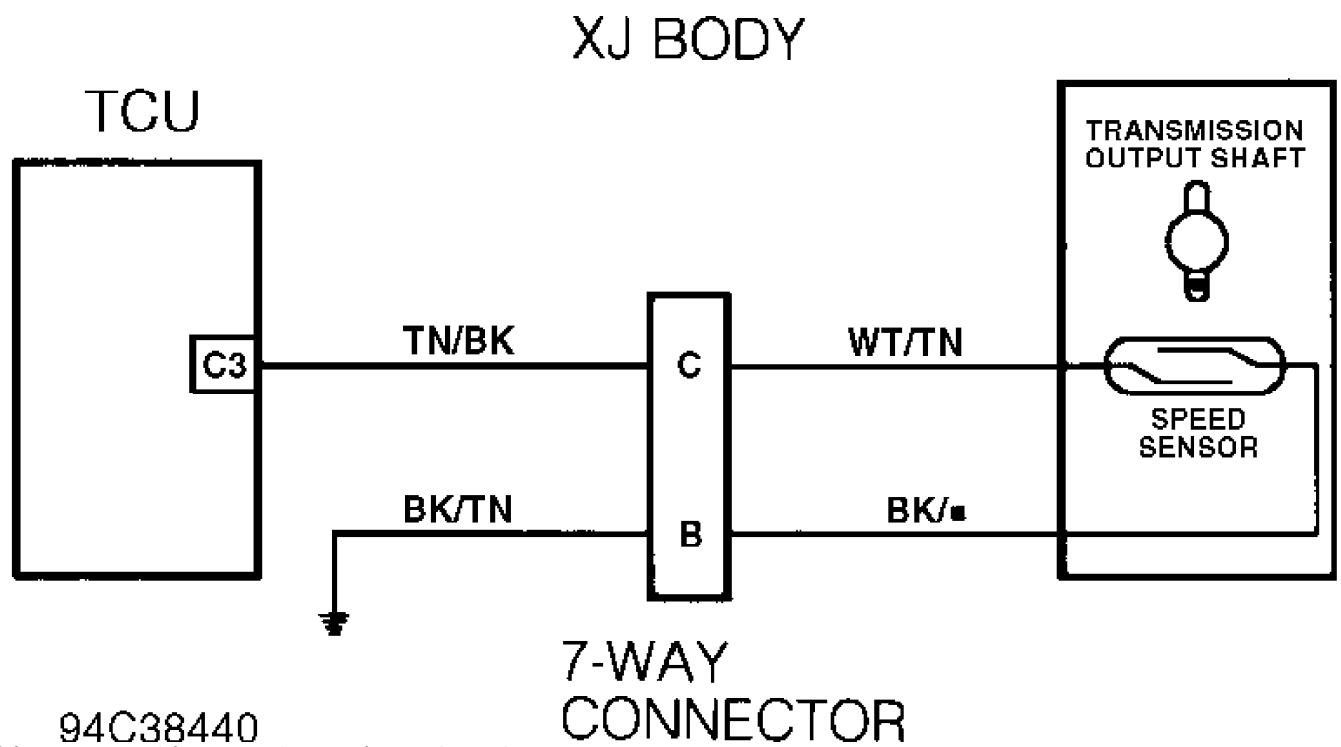


Fig. 120: Test 10A - Schematic (Cherokee)

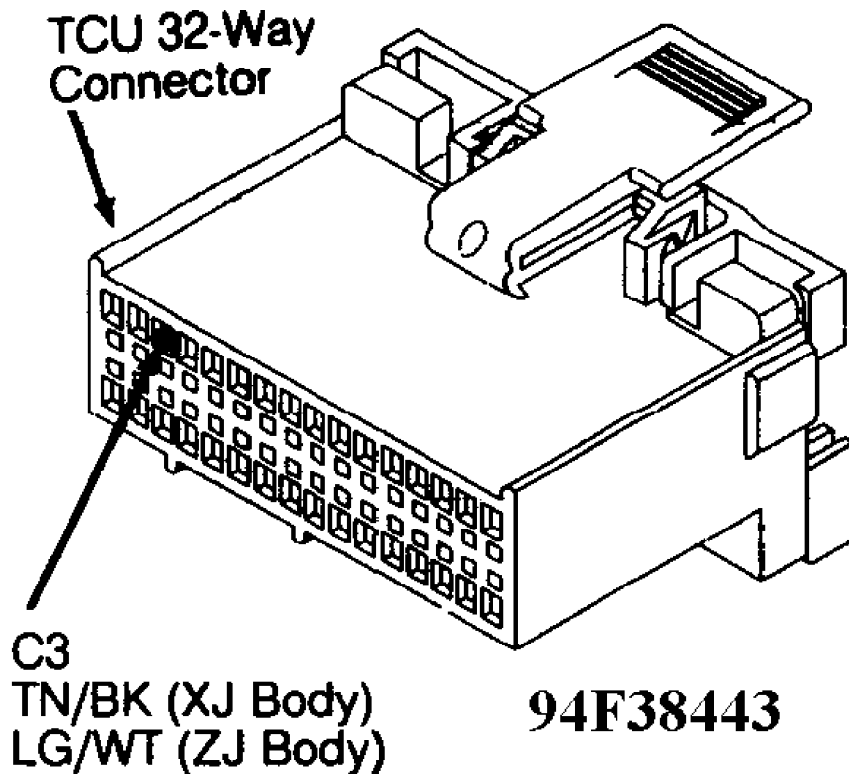


Fig. 121: Test 10A - TCU 32-Way Connector (Cavity 3)

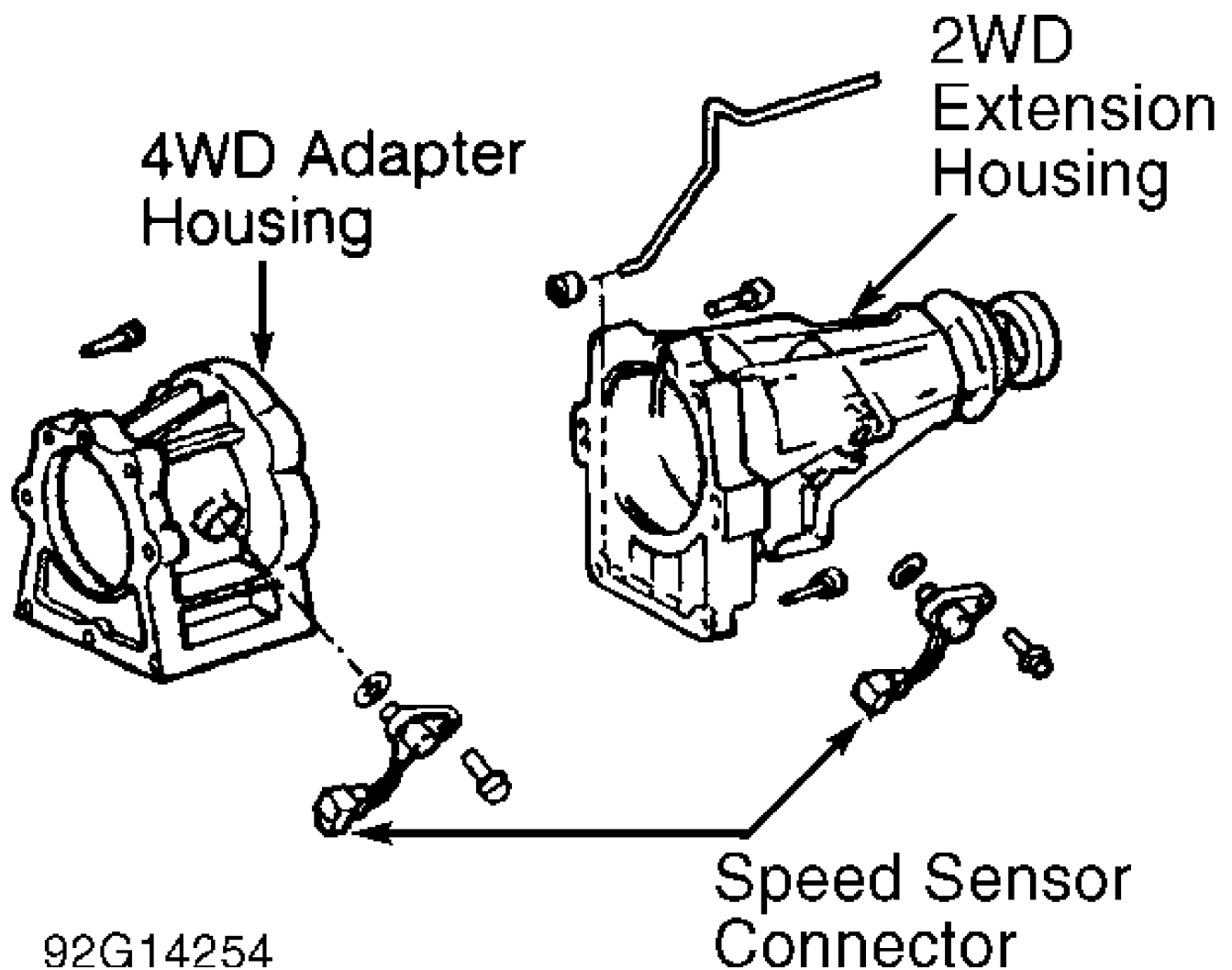


Fig. 122: Test 10A - Location of Speed Sensor Connector

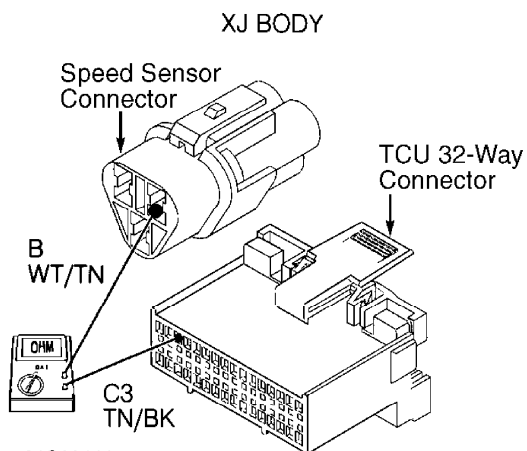


Fig. 123: Test 10A - Testing Speed Sensor (Cherokee)

## WIRING DIAGRAMS

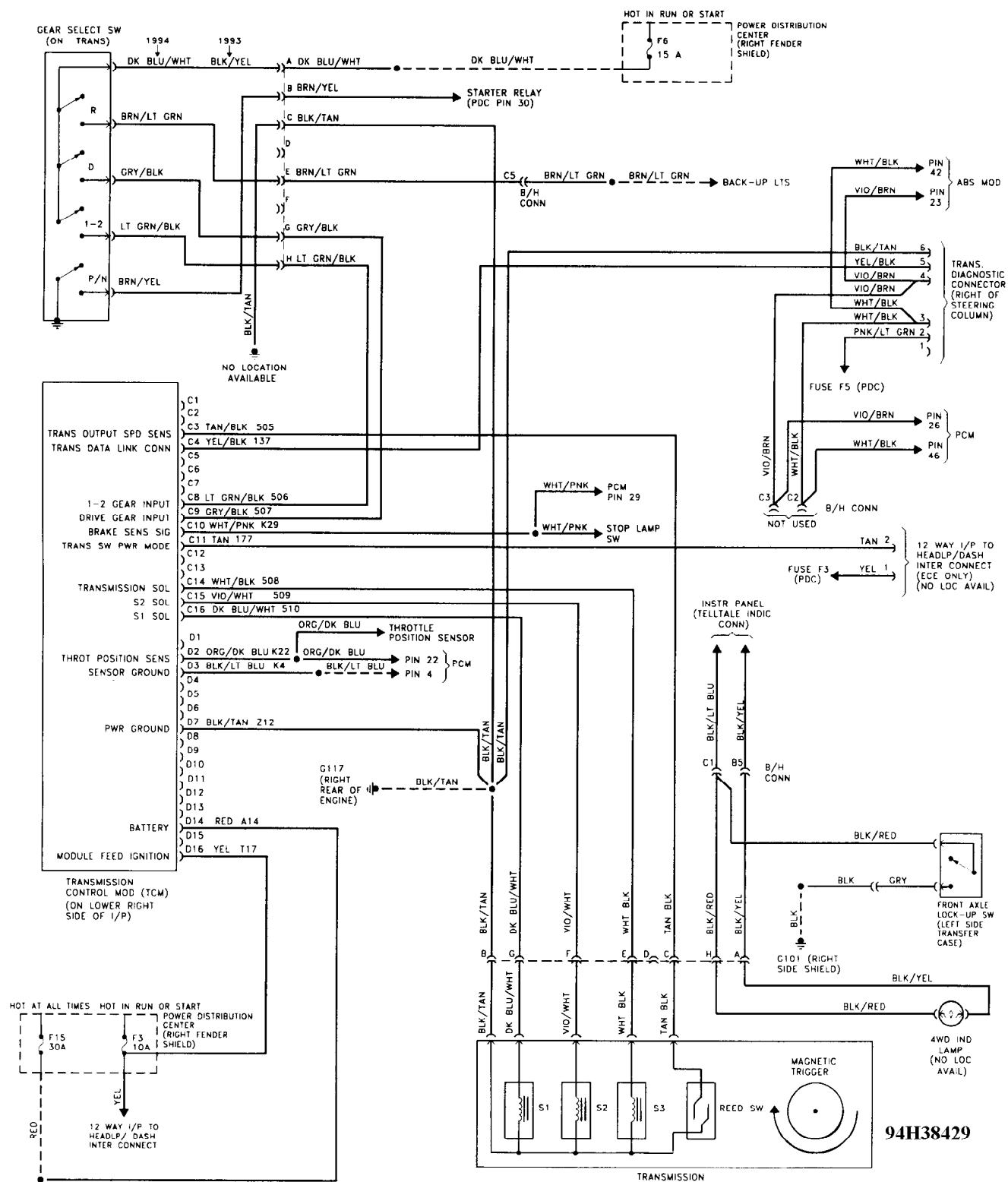
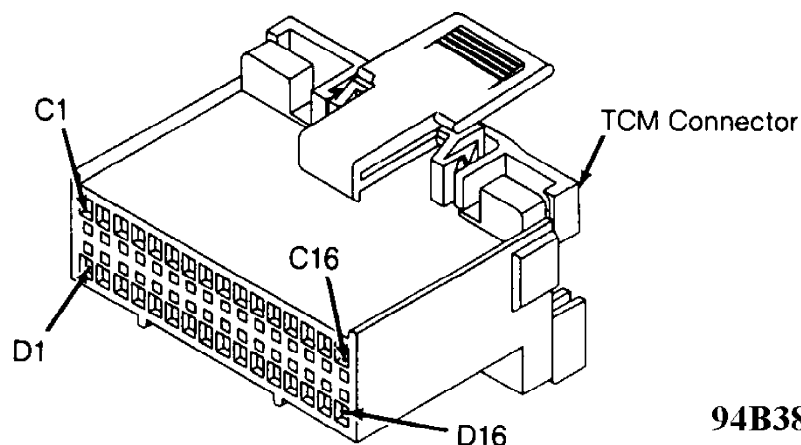


Fig. 124: Transmission Wiring Diagram (Cherokee)



94B38431

#### CHEROKEE

CAV ... CIRCUIT .....	FUNCTION
C1-C2 .....	Not Used
C3 .....	505 TN/BK ..... Trans Speed Sensor
C4 .....	137 YL/BK ..... Auto Trans Diagnostic
C5-C7 .....	Not Used
C8 .....	506 LG/BK ..... Low (1-2) Input
C9 .....	507 GY/BK ..... Drive (3) Input
C10 .....	K29 WT/PK ..... Brake Input
C11 .....	Not Used
C12-C13 .....	Not Used
C14 .....	508 WT/BK ..... S3 Solenoid (Converter Lockup)
C15 .....	509 VT/WT ..... S2 Solenoid
C16 .....	510 DB/WT ..... S1 Solenoid
D1 .....	Not Used
D2 .....	K22 OR/DB ..... Throttle Position Sensor
D3 .....	K4 BK/LB ..... TPS Signal Ground
D4-D6 .....	Not Used
D7 .....	Z12 BK/TN ..... Power Ground
D8-D13 .....	Not Used
D14 .....	A14 RD ..... Battery
D15 .....	Not Used
D16 .....	T17 YL ..... Ignition (Run/On)

#### GRAND CHEROKEE

CAV... CIRCUIT .....	FUNCTION
C1-C2 .....	Not Used
C3 .....	T14 LG/WT ..... Trans Speed Sensor
C4 .....	D82 BK/YL ..... Auto Trans Diagnostic
C5-C7 .....	Not Used
C8 .....	T25 LG ..... Low (1-2) Input
C9 .....	T50 DG ..... Drive (3) Input
C10 .....	L53 BR ..... Brake Input
C11-C13 .....	Not Used
C14 .....	T20 LB/BR ..... S3 Solenoid (Converter Lockup)
C15 .....	T59 PK ..... S2 Solenoid
C16 .....	T60 BR/YL ..... S1 Solenoid
D1 .....	Not Used
D2 .....	K22 OR/DB ..... Throttle Position Sensor
D3 .....	K4 BK/LB ..... TPS Signal Ground
D4-D6 .....	Not Used
D7 .....	Z1 BK ..... Power Ground
D8-D13 .....	Not Used
D14 .....	A14 RD/WT ..... Battery
D15 .....	Not Used
D16 .....	F86 LB/RD ..... Ignition (Run/On)

Fig. 125: TCM Connector Terminals I.D., Circuits & Functions  
Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

### BRAKE SWITCH R & I

#### Removal

Remove lower steering column cover or trim panels for access to brake switch (if necessary). Disconnect brake switch electrical connector. Thread brake switch from retainer and remove.

#### Installation

1) Install brake switch in retainer. Reconnect brake switch electrical connector.

2) To check brake switch adjustment, slightly depress brake pedal and note operation of brake switch plunger. Brake switch plunger should fully extend when brake pedal free play is taken up and brake application begins.

3) Clearance between brake switch plunger and brake pedal should be approximately 1/8". If clearance is not within specification, pull brake pedal rearward as far as possible.

4) Brake pedal should contact brake switch plunger, pushing brake switch backward in retainer to provide proper adjustment. Ensure brake lights operate.

5) Recheck clearance between brake switch plunger and brake pedal with brake pedal depressed and free play taken up. Reinstall lower steering column cover or trim panels.

### NEUTRAL SAFETY SWITCH R & I

NOTE: Neutral safety switch may be referred to as park/neutral or gear select switch.

#### Removal

1) Apply parking brake. Raise and support vehicle. Disconnect electrical connector at neutral safety switch. Pry lock washer tabs away from retaining nut. See Fig. 126.

2) Remove retaining nut, lock washer and adjusting bolt. See Fig. 126. Remove neutral safety switch from manual valve shaft.

#### Installation

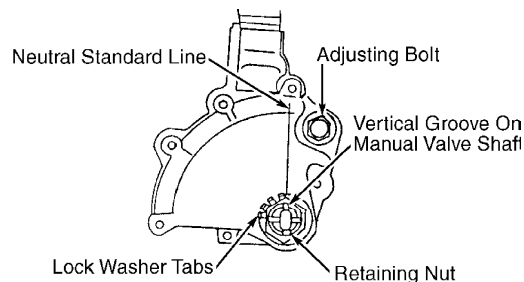
1) Disconnect shift control rod from transmission shift lever. Rotate transmission shift lever fully rearward and then forward 2 detents to Neutral position.

2) Install neutral safety switch on manual valve shaft. Install adjusting bolt but DO NOT tighten at this time.

3) Install lock washer and retaining nut. Tighten retaining nut to specification. See TORQUE SPECIFICATIONS. DO NOT bend over lock washer tabs at this time.

4) Ensure transmission is still in Neutral. Rotate neutral safety switch and align neutral standard line with vertical groove on manual valve shaft. See Fig. 126.

5) Tighten adjusting bolt to specification. See TORQUE SPECIFICATIONS at end of article. Bend lock washer tabs over. Reconnect shift control rod and electrical connector. Ensure vehicle starts in Park and Neutral only.



92G13454  
Fig. 126: Installing Neutral Safety Switch  
Courtesy of Chrysler Corp.

### SPEED SENSOR R & I

#### Removal & Installation

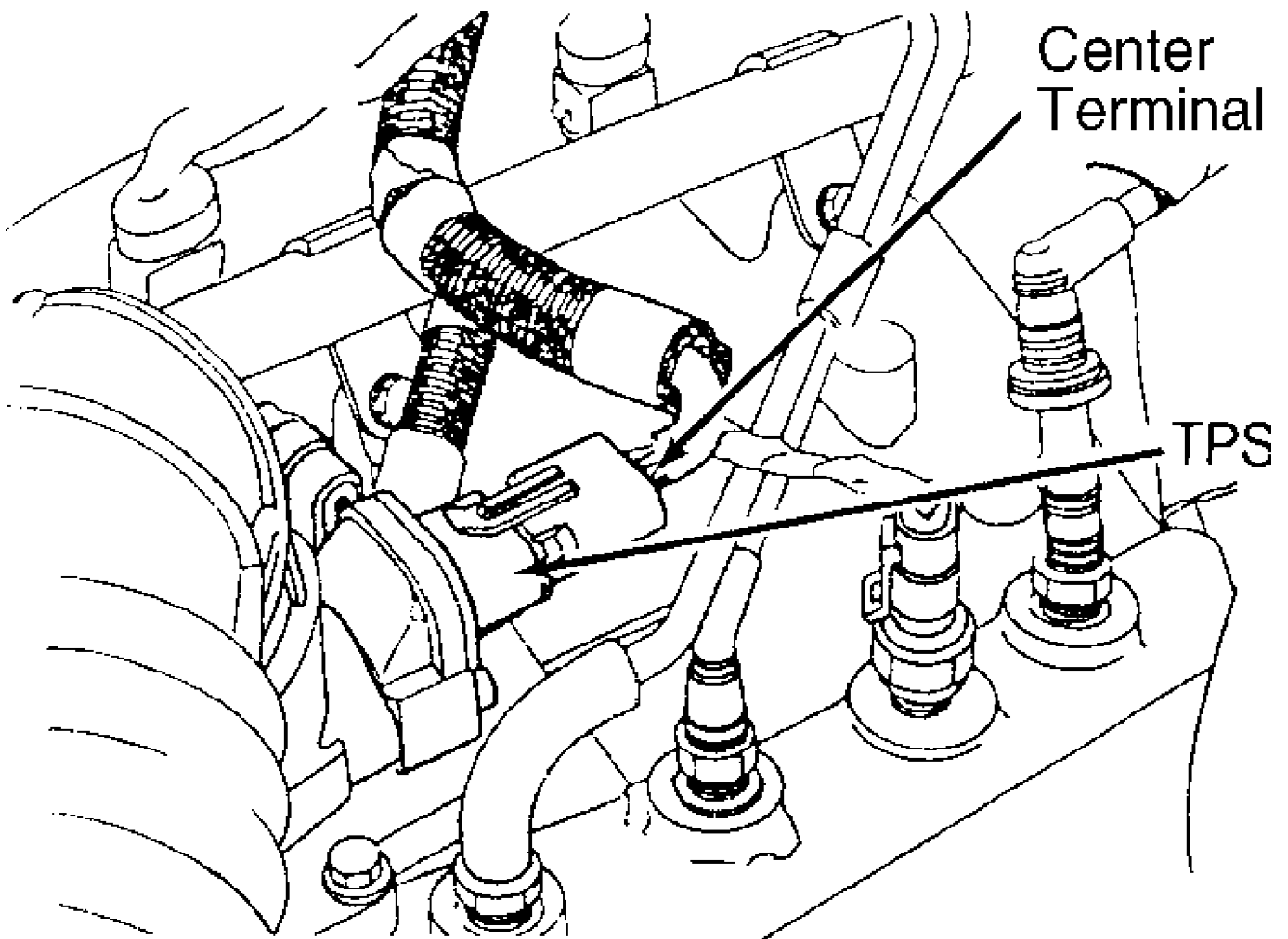
1) Disconnect electrical connector at speed sensor located on adapter housing or extension housing. Remove bolt and speed sensor. Remove "O" ring from speed sensor.

2) To install, reverse removal procedure using NEW "O" ring. Tighten bolt to specification. See TORQUE SPECIFICATIONS.

### THROTTLE POSITION SENSOR (TPS) R & I

#### Removal & Installation

1) Note location of TPS electrical connector. See Fig. 127. Disconnect electrical connector. Remove screws and TPS.



92113514

Fig. 127: Identifying TPS Electrical Connector  
Courtesy of Chrysler Corp.

2) To install, reverse removal procedure. Ensure throttle shaft on throttle body engages socket tangs on TPS. See Fig. 128. Tighten screws. Manually operate throttle and ensure no binding exists. Reinstall electrical connector.

NOTE: TPS must be installed so it can be rotated a few degrees. If TPS cannot be rotated, reinstall TPS with end of throttle

shaft on other side of TPS socket tangs.

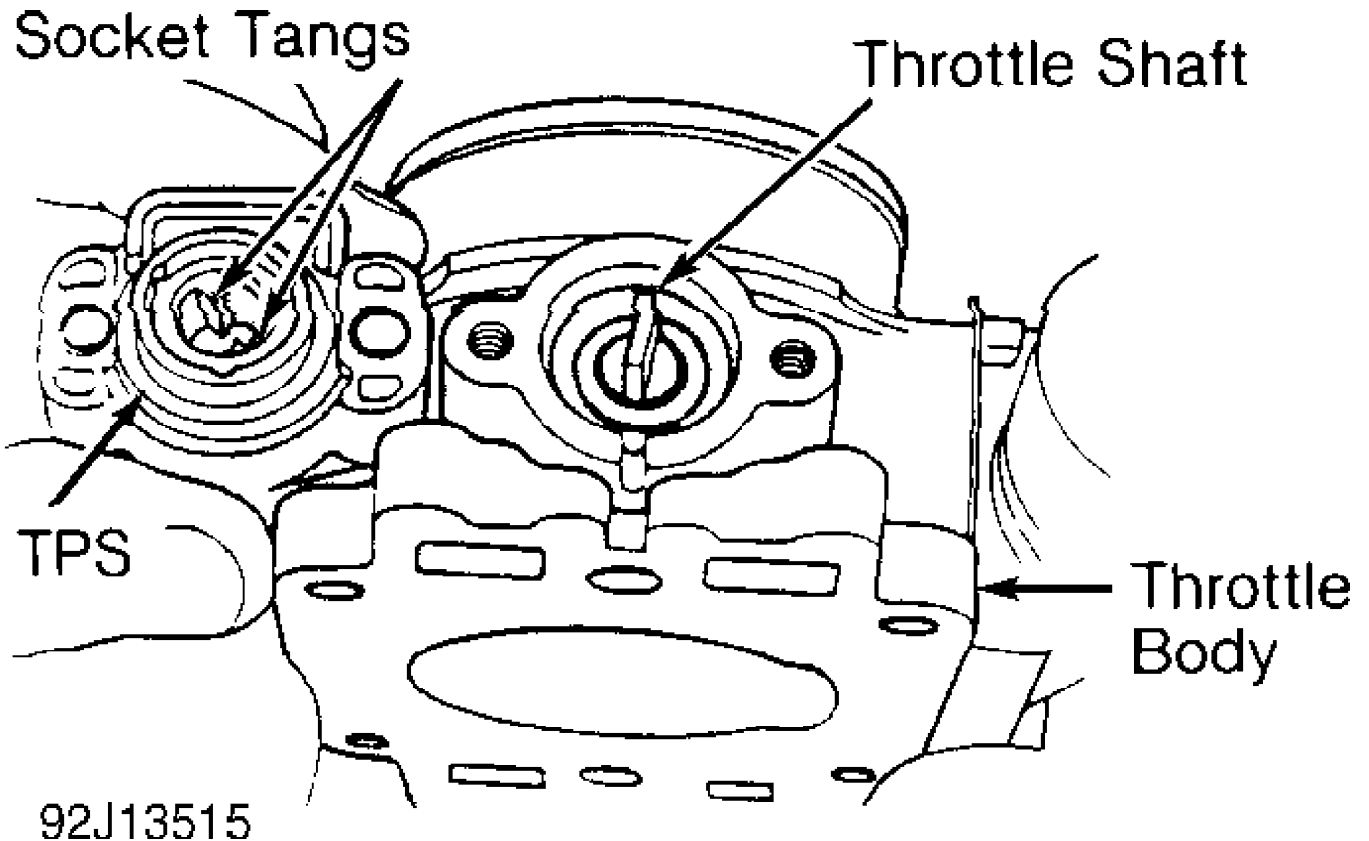
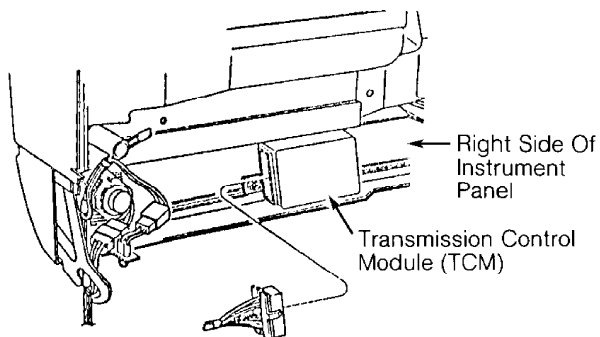


Fig. 128: Installing Throttle Position Sensor (TPS)  
Courtesy of Chrysler Corp.

#### TRANSMISSION CONTROL MODULE (TCM) R & I

Removal & Installation (Cherokee)

Ensure ignition is off. Disconnect electrical connector from TCM, located behind right side of instrument panel. See Fig. 129. Remove fastener and TCM from instrument panel. To install, reverse removal procedure.



94F38401  
Fig. 129: Transmission Control Module (TCM) I.D. (Cherokee)  
Courtesy of Chrysler Corp.

#### VALVE BODY SOLENOID R & I

#### Removal

1) Raise and support vehicle. Remove drain plug and drain transmission fluid. Remove bolts and oil pan. Remove bolts, oil screen and gasket.

2) Disconnect electrical connectors from valve body solenoid. Mark electrical connector location for reassembly reference if more than one valve body solenoid is being removed. Remove bolt, valve body solenoid and "O" ring.

CAUTION: DO NOT allow components to fall from valve body when removing valve body solenoid.

#### Installation

1) To install, reverse removal procedure using NEW "O" ring and NEW gaskets. Tighten valve body solenoid bolt and oil screen bolt to specification. See TORQUE SPECIFICATIONS.

2) Ensure magnet is installed in oil pan and does not interfere with valve body oil tubes. Apply 1/8" bead of Loctite 599 sealant on oil pan mounting flange. Install oil pan. Install and tighten bolts to specification. See TORQUE SPECIFICATIONS.

3) Install NEW gasket and drain plug. Tighten drain plug to specification. See TORQUE SPECIFICATIONS. Fill transmission to proper fluid level with Mopar Dexron-IIE/Mercon ATF.

## TORQUE SPECIFICATIONS

#### TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Drain Plug .....	15 (20)
	INCH Lbs. (N.m)
Neutral Safety Switch Adjusting Bolt .....	108 (12.2)
Neutral Safety Switch Retaining Nut .....	61 (6.9)
Oil Pan Bolt .....	65 (7.3)
Oil Screen Bolt .....	84 (9.5)
Speed Sensor Bolt .....	65 (7.3)
Valve Body Solenoid Bolt .....	84 (9.5)



# G - TESTS W/CODES - 2.5L & 4.0L

## 1993 Jeep Cherokee

1993 ENGINE PERFORMANCE  
Chrysler Corp 2.5L & 4.0L Self-Diagnostics

Jeep; Cherokee, Grand Cherokee, Wrangler

NOTE: For Grand Cherokee with 5.2L engine, see G - 5.2L TESTS W/CODES article in the ENGINE PERFORMANCE Section.

### INTRODUCTION

If no faults were found while performing F - 2.5L & 4.0L BASIC TESTING, proceed with self-diagnostics. If no fault codes or only pass codes are present after entering self-diagnostics, proceed to H - TESTS W/O CODES article in the ENGINE PERFORMANCE Section for diagnosis by symptom (i.e. ROUGH IDLE, NO START, etc.).

### SYSTEM DIAGNOSTICS

NOTE: Malfunction Indicator Light (MIL) may also be referred to as CHECK ENGINE light.

The self-diagnostic capabilities of this system, if properly utilized, can simplify testing. The Powertrain Control Module (PCM) monitors several different engine control system circuits.

If a problem is sensed with a monitored circuit, PCM memory stores a fault, the MIL glows and PCM enters limp-in mode. In limp-in mode, PCM compensates for component failure by substituting information from other sources. This allows vehicle operation until repairs can be made.

Test circuits and repair or replace components as required. If problem is repaired or ceases to exist, the PCM cancels fault after 50 ignition on/off cycles.

A specific fault results from a particular system failure. A fault does not condemn a specific component; component is not necessarily the reason for failure. Faults only call out a probable malfunction area.

#### Hard Failures

Hard failures cause MIL to glow and remain on until the malfunction is repaired. If light comes on and remains on (light may flash) during vehicle operation, cause of malfunction must be determined using self-diagnostic tests. If a sensor fails, PCM will use a substitute value in its calculations, allowing engine to operate in limp-in mode. In this condition, vehicle will run, but driveability may be poor.

#### Intermittent Failures

Intermittent failures may cause MIL to flicker or stay on until the intermittent fault goes away. However, the corresponding fault will be retained in PCM memory. If related fault does not reoccur within a certain time frame, related fault will be erased from PCM memory. Intermittent failures can be caused by a faulty sensor, bad connector or wiring related problems.

### MODEL IDENTIFICATION

#### VEHICLE BODY IDENTIFICATION TABLE

Model Name	Body Type
------------	-----------

Cherokee .....	XJ
Grand Cherokee .....	ZJ
Wrangler .....	YJ

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## SELF-DIAGNOSTIC SYSTEM

### SERVICE PRECAUTIONS

Before proceeding with diagnosis, the following precautions must be followed:

- \* ALWAYS relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components. See FUEL PRESSURE RELEASE.
- \* When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION Section before disconnecting battery.
- \* Vehicle must have a fully charged battery and functional charging system.
- \* Probe PCM 60-pin connector from pin side. DO NOT backprobe PCM connector.
- \* DO NOT cause short circuits when performing electrical tests. This will set additional faults, making diagnosis of original problem more difficult.
- \* DO NOT use a test light instead of a voltmeter.
- \* When checking for spark, ensure coil wire is NO more than 1/4" from ground. If coil wire is more than 1/4" from ground, damage to vehicle electronics and/or PCM may result.
- \* DO NOT prolong testing of fuel injectors or engine may hydrostatically (liquid) lock.
- \* Always repair lowest fault code number (MIL) or first fault displayed (DRB-II) first.
- \* Always perform verification test after repairs are made.
- \* Always disconnect DRB-II after use.
- \* Always disconnect DRB-II before charging battery.

### FUEL PRESSURE RELEASE

**WARNING:** Always relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components.

**CAUTION:** When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION Section before disconnecting battery.

1) Disconnect negative battery cable. Slowly open fuel tank cap to release fuel tank pressure. Remove protective cap from pressure test port on fuel rail. See Fig. 1.

2) Using Fuel Pressure Gauge Tool Set (5069), obtain fuel pressure gauge and hose assembly. Remove gauge from hose. Place gauge end of hose in approved gasoline container. Place shop towel under test port. Screw other end of hose onto fuel pressure test port. Release fuel pressure. After pressure is released, remove hose from test port. Install protective cap on pressure test port.

3) If gauge tool set is not available, perform step 1). Using

a small screwdriver, wrapped in shop towels, push test port valve in to relieve fuel pressure. Absorb spilled fuel with shop towels. Remove shop towels and dispose of properly. Install protective cap on pressure test port.

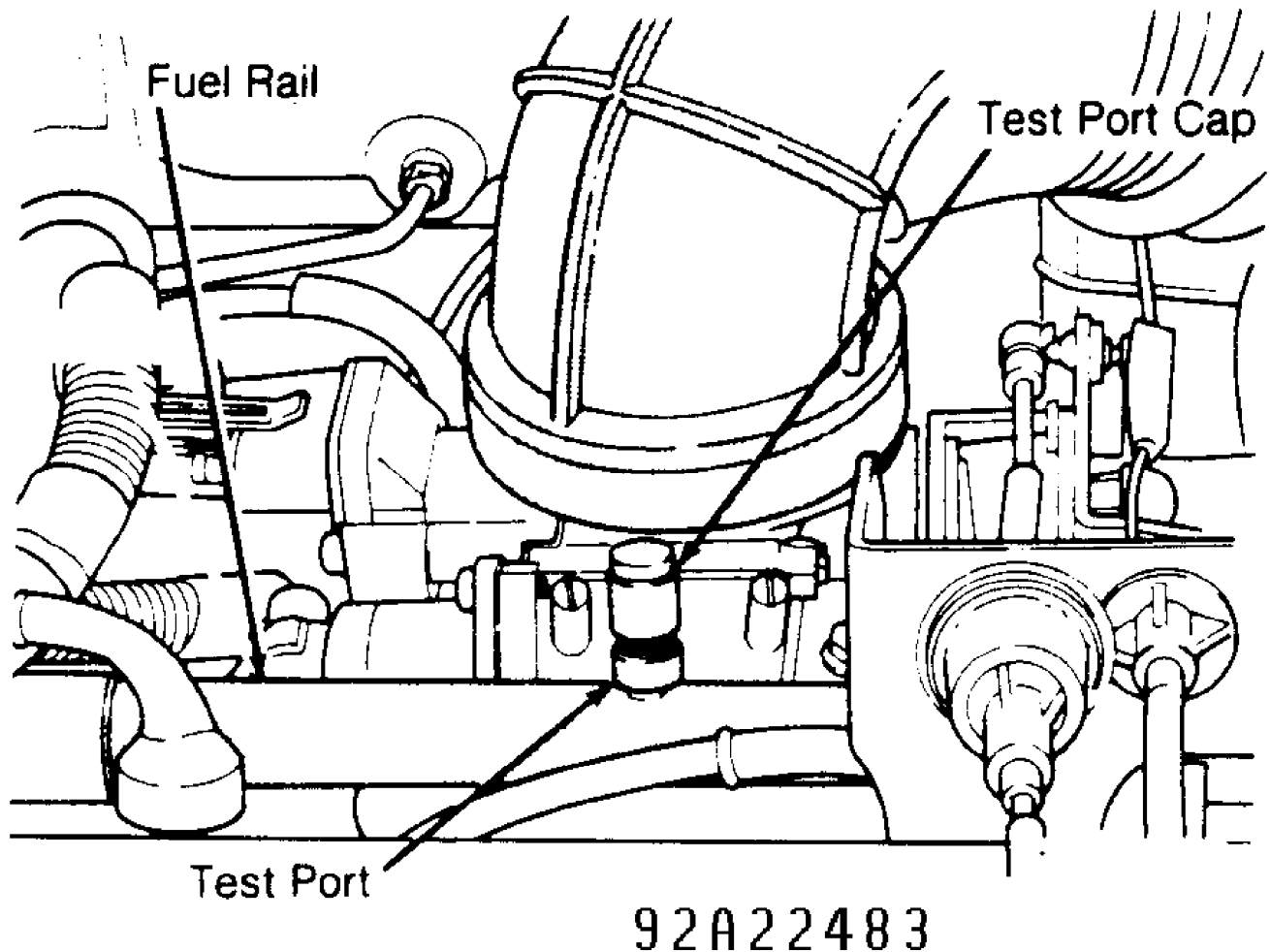


Fig. 1: Releasing Fuel Pressure  
Courtesy of Chrysler Corp.

## VISUAL INSPECTION

Most driveability problems in the engine control system result from faulty wiring, poor electrical connections or leaking air and vacuum hose connections. To avoid unnecessary component testing, perform a visual inspection before beginning self-diagnostic tests.

## DIAGNOSTIC PROCEDURE

**NOTE:** DO NOT skip any steps in self-diagnostic tests or incorrect diagnosis may result.

Always perform a visual inspection before attempting to diagnose engine control system problems. See VISUAL INSPECTION. Enter on-board diagnostics, and retrieve fault code(s). See ENTERING ON-BOARD DIAGNOSTICS. If fault codes are not present and/or DRB-II (Diagnostic Readout Box II) is used, proceed to one of the following

tests:

- \* Go to TEST NS-1A (QUALIFYING NO START CONDITION) if a no start condition exists or engine stalls after start-up. Perform indicated VERIFICATION TEST after repairs have been made.
- \* Go to TEST FC-1A (CHECKING FOR FAULTS) if engine runs but has performance problems. Perform indicated VERIFICATION TEST after repairs have been made.
- \* Go to TEST NF-1A (NO FAULT TEST CODE MENU) if a driveability problem exists and no fault codes are present. Perform indicated VERIFICATION TEST after repairs have been made.

## ENTERING ON-BOARD DIAGNOSTICS

NOTE: Although other scan testers are available, manufacturer recommends using DRB-II (Diagnostic Readout Box II) to diagnose the system. MIL function can be used but has limited diagnostic capability.

### DRB-II Diagnostic Mode

1) Ensure ignition is off. Attach DRB-II to engine diagnostic connector. Connector is located on left side (right side on Grand Cherokee) of engine compartment, near PCM. See Figs. 2 and 3. Start engine (if possible). Turn A/C system on, then off (if equipped).

2) Turn engine off. Without starting engine, turn ignition on and access READ FAULTS function of DRB-II FUEL/IGN MENU.

3) Record all fault messages displayed by DRB-II, and observe MIL on instrument cluster. MIL should come on for 3 seconds and then go out (bulb check).

### MIL Diagnostic Mode

1) Start engine (if possible). Move transmission shift lever through all positions, ending in Park. Turn A/C switch on and then off (if equipped).

2) Turn engine off. Without starting engine again, turn ignition on, off, on, off and on within 5 seconds. Record 2-digit fault codes as displayed by flashing MIL.

3) For example, fault code 23 is displayed as flash, flash, 4-second pause, flash, flash, flash. After a slightly longer pause, other codes stored are displayed in numerical order. When MIL begins to flash fault codes, it cannot be stopped. Start over if count is lost. Code 55 indicates end of fault code display.

4) Refer to FAULT CODES/MESSAGE table to translate trouble code number to a DRB-II fault message. Once trouble area is identified, refer to TEST FC-1A. Use DRB-II fault messages to find appropriate test.

5) As an example, a 2.5L engine starts and runs but has a driveability problem. MIL indicates Code 14. Refer to FAULT CODES/MESSAGES to translate trouble code number to DRB-II fault message. When DRB-II fault message is obtained, refer to appropriate test number. To clear fault codes, see CLEARING FAULTS.

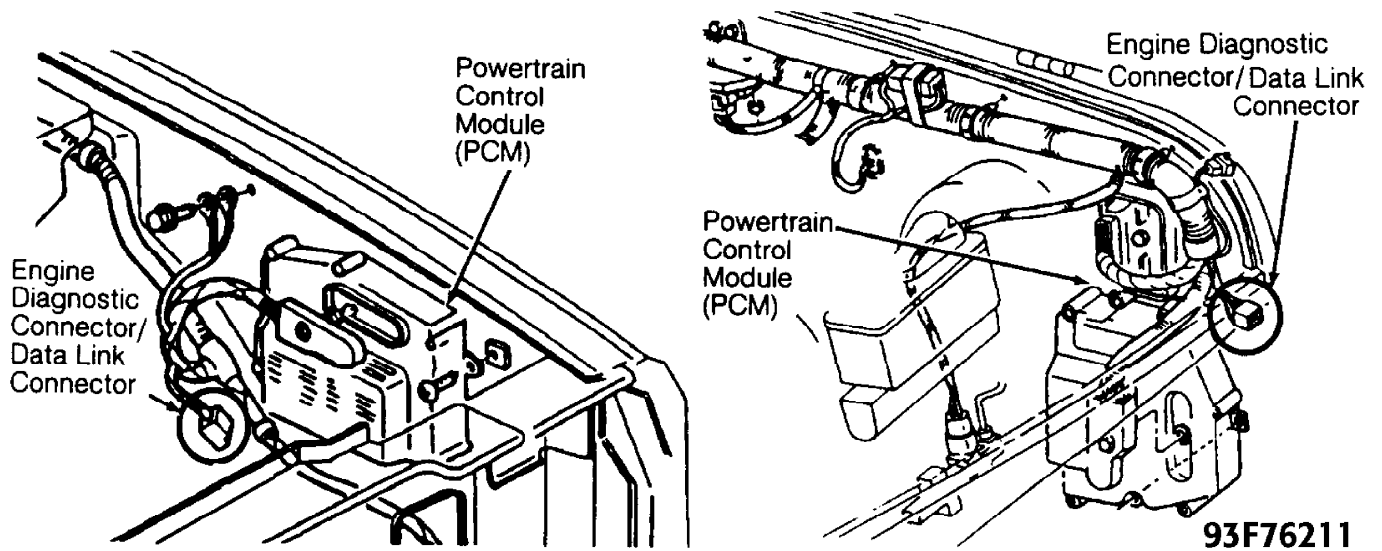


Fig. 2: Locating Diagnostic Connector (Cherokee & Wrangler)  
Courtesy of Chrysler Corp.

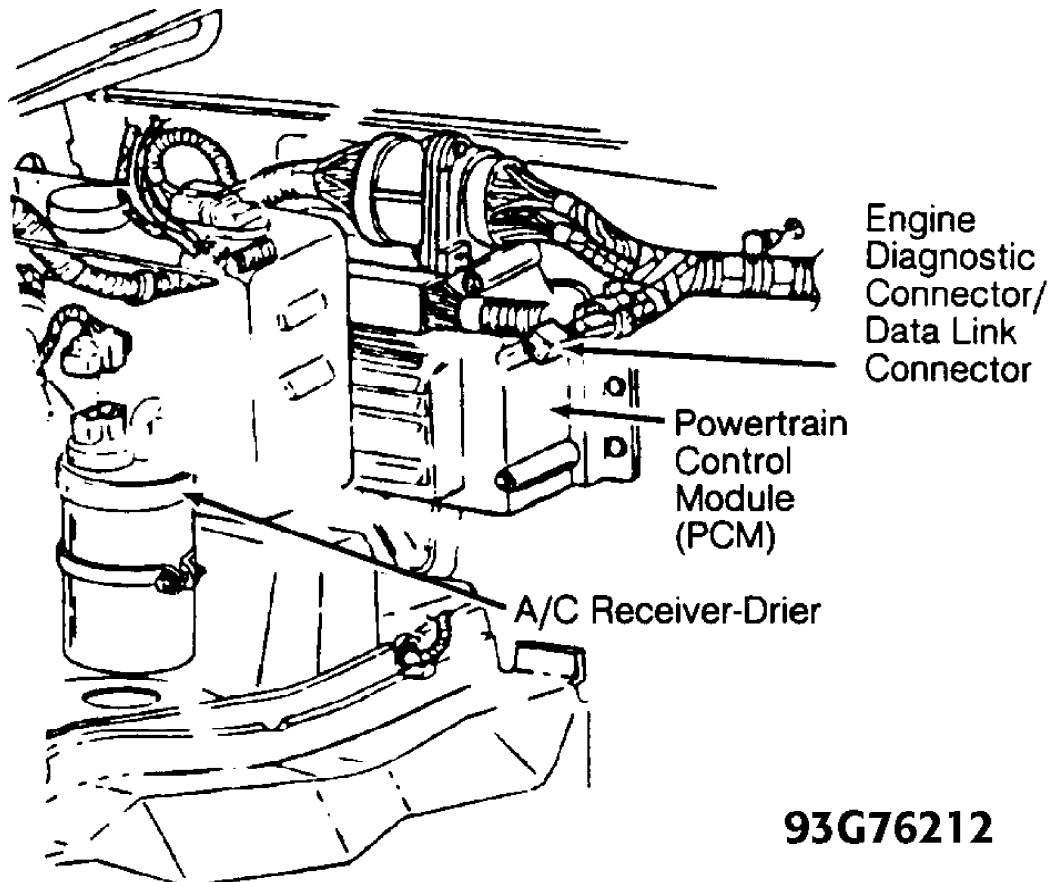


Fig. 3: Locating Diagnostic Connector (Grand Cherokee)  
Courtesy of Chrysler Corp.

## CLEARING FAULTS

**CAUTION:** When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION Section before disconnecting battery.

1) If DRB-II is not available, go to step 3). If DRB-II is available, press "1" key selecting FUEL/IGNITION. Press "2" key selecting READ FAULTS. Press down arrow key selecting next screen. Press "2" key selecting ERASE.

2) DRB-II will display ERASE FAULTS ARE YOU SURE? (ENTER TO ERASE). Press ENTER key. When DRB-II is finished erasing faults, screen will display FAULTS ERASED.

3) Fault codes may be cleared by disconnecting negative battery cable for at least 15 seconds, allowing PCM to clear faults.

## **INACTIVE FAULT CONDITION**

This procedure applies if you have been sent here from diagnostic tests and have just attempted to simulate the condition that initially set the fault message. The following additional checks may assist in identifying a possible intermittent problem:

- \* Visually inspect related wiring harness connectors for broken, bent, pushed out or corroded terminals.
- \* Visually inspect related wiring harnesses for chafed, pierced or partially broken wires.
- \* Check all pertinent MITCHELL(R) TECH SERVICE BULLETINS (TSBs).

## **USING DRB-II**

**NOTE:** Although other scan testers are available, manufacturer recommends using DRB-II (Diagnostic Readout Box II) to diagnose the system.

Ensure DRB-II is connected to engine diagnostic connector located in engine compartment. Ensure correct cartridge is installed in DRB-II for vehicle and system being diagnosed. Menu selections will vary depending on vehicle and system being diagnosed. Follow DRB-II screen prompts to actuate, adjust, monitor, reset, test and diagnose system as necessary.

DRB-II is grounded through engine diagnostic connector. Only one volt-ohmmeter test lead is required when using volt-ohmmeter option. DRB-II volt-ohmmeter should only be used when self-diagnostic tests require the use of this option.

If DRB-II has a blank screen or displays RAM TEST FAILURE, CARTRIDGE ERROR, KEY PAD TEST FAILURE or LOW BATTERY OR HIGH BATTERY, this indicates a DRB-II failure. To diagnose and correct these conditions, see G - BODY TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

## **SERVICE REMINDER INDICATOR (SRI) MEMORY TEST**

**NOTE:** Perform SRI memory test only if referred here by diagnostic tests.

1) To perform SRI memory check, ensure ignition is off. Attach DRB-II to engine diagnostic connector. Connector is located on left side (right side on Grand Cherokee) of engine compartment, near PCM. See Figs. 2 and 3. Turn ignition switch to RUN position.

2) Copyright information and diagnostic program version will appear on screen for a few seconds. After a few seconds DRB-II menu will appear. At FUEL/IGN MENU, press "5" (ADJUSTMENTS) key. Press ENTER key. At ADJUSTMENTS menu, press "4" (SRI MEMORY CHK) key. Press ENTER key. The DRB-II display will read SRI MEMORY CHECK ARE YOU SURE? (ENTER TO CONTINUE).

3) Press ENTER key. The DRB-II will display SRI MEMORY TEST WRITE TEST [————] and after a few seconds IS INSTRUMENT PANEL MILEAGE BETWEEN XXXXX AND XXXXX? (PRESS YES OR NO). If vehicle mileage is within specification, SRI memory check is complete. Press YES key. If vehicle mileage is not within specification, go to next step.

4) Press NO key. DRB-II will display ENTER MILEAGE SHOWN ON INSTRUMENT PANEL (USE ENTER TO END) XXXXXXX. Enter vehicle mileage. DO NOT enter tenths. When correct vehicle mileage is entered, press ENTER key.

5) DRB-II will ask for verification of mileage entry. If mileage entry was accurate, press ENTER key. DRB-II will display SRI MEMORY CHECK COMPLETE. Vehicle must travel at least 8 miles for reset to occur.

## SERVICE REMINDER INDICATOR (SRI) LIGHT RESET PROCEDURE

Service Reminder Indicator (SRI) light is designed to be a reminder to service vehicle emissions control system. It is not an emissions warning system, only a reminder to perform necessary emissions servicing.

Components to be serviced include PCV valve, oxygen sensor and some vacuum-operated components. SRI light will illuminate after a predetermined mileage.

1) To reset SRI light, ensure ignition is off. Connect DRB-II to engine diagnostic connector. Connector is located on left side (right side on Grand Cherokee) of engine compartment, near PCM. See Figs. 2 and 3. Turn ignition switch to RUN position.

2) Copyright information and diagnostic program version will appear on screen for a few seconds. After a few seconds, DRB-II menu will appear. At FUEL/IGN MENU, press "5" (ADJUSTMENTS) key. Press ENTER key.

3) At ADJUSTMENTS menu, press "3" (RESET SRI LIGHT) key. Press ENTER key. Display will read RESET SRI LIGHT ARE YOUR SURE? (ENTER TO RESET). Press ENTER key.

## SERVICE REMINDER INDICATOR (SRI) MILEAGE TRANSFER

NOTE: Perform mileage transfer procedure only if PCM is being replaced.

1) When PCM is replaced, vehicle mileage must be copied from odometer to replacement PCM memory. Transfer of vehicle mileage will enable new PCM to operate SRI light properly.

2) To transfer mileage to new PCM, ensure ignition is off. Connect DRB-II to engine diagnostic connector. Connector is located on left side (right side on Grand Cherokee) of engine compartment, near PCM. See Figs. 2 and 3. Turn ignition switch to RUN position.

3) Copyright information and diagnostic program version will appear on screen for a few seconds. After a few seconds DRB-II menu will appear. At FUEL/IGN MENU, press "5" (ADJUSTMENTS) key. Press ENTER key. At ADJUSTMENTS menu, press "4" (SRI MEMORY CHK) key. Press ENTER key. The DRB-II display will read SRI MEMORY CHECK ARE YOU SURE? (ENTER TO CONTINUE).

4) Press ENTER key. The DRB-II will display SRI MEMORY TEST WRITE TEST [————] and after a few seconds IS INSTRUMENT PANEL MILEAGE BETWEEN XXXXX AND XXXXX? (PRESS YES OR NO). If vehicle mileage is within specification, SRI memory check is complete. Press YES key.

If vehicle mileage is not within specification, go to next step.

5) Press NO key. DRB-II will display ENTER MILEAGE SHOWN ON INSTRUMENT PANEL (USE ENTER TO END) XXXXXXXX. Enter vehicle mileage. DO NOT enter tenths. When correct vehicle mileage is entered, press ENTER key.

6) DRB-II will ask for verification of mileage entry. If mileage entry was accurate, press ENTER key. DRB-II will display SRI MEMORY CHECK COMPLETE. Vehicle must travel at least 8 miles for reset to occur.

## **THEFT ALARM SYSTEM**

NOTE: If SECURITY light comes on and remains on with ignition on, Chrysler Collision Detection (CCD) bus communication with PCM has been lost. After servicing vehicle, ensure system operates properly. A malfunctioning anti-theft alarm system may keep engine from starting. For anti-theft alarm diagnosis, see appropriate ANTI-THEFT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT Section.

## **FAULT CODES/MESSAGES**

NOTE: Not all fault codes apply to all vehicles. Some fault codes have more than one meaning. When a fault code has more than one meaning, MIL is unable to distinguish between different failures.

Code 11

DRB-II displays NO CRANK REFERENCE SIGNAL AT PCM. Condition is: no crankshaft reference signal picked up during cranking.

Code 13

DRB-II displays SLOW CHANGE IN IDLE MAP SENSOR SIGNAL. Condition is: Manifold Absolute Pressure (MAP) sensor output change slower and/or smaller than expected.

Code 13

DRB-II displays NO CHANGE IN MAP FROM START TO RUN. Condition is: no difference recognized between Manifold Absolute Pressure (MAP) reading and barometric (atmospheric) pressure reading at start-up.

Code 14

DRB-II displays MAP VOLTAGE TOO LOW. Condition is: Manifold Absolute Pressure (MAP) sensor input less than minimum acceptable voltage.

Code 14

DRB-II displays MAP VOLTAGE TOO HIGH. Condition is: Manifold Absolute Pressure (MAP) sensor input more than maximum acceptable voltage.

Code 15

DRB-II displays NO VEHICLE SPEED SENSOR SIGNAL. Condition is: no Vehicle Speed Sensor (VSS) signal detected with road load conditions.

Code 17

DRB-II displays ENGINE IS COLD TOO LONG. Condition is: coolant temperature stays less than normal operating temperature during vehicle operation.

Code 21



DRB-II displays O2S STAYS AT CENTER. Condition is: no rich or lean signal detected from oxygen sensor input.

Code 21

DRB-II displays O2S SHORTED TO VOLTAGE. Condition is: oxygen sensor input voltage maintained at more than normal operating range.

Code 22

DRB-II displays ECT SENSOR VOLTAGE TOO LOW. Condition is: Engine Coolant Temperature (ECT) sensor input less than minimum acceptable voltage.

Code 22

DRB-II displays ECT SENSOR VOLTAGE TOO HIGH. Condition is: Engine Coolant Temperature (ECT) sensor input more than maximum acceptable voltage.

Code 23

DRB-II displays INTAKE AIR TEMPERATURE SENSOR VOLTAGE LOW. Condition is: Intake Air Temperature (IAT) sensor input less than minimum acceptable voltage.

Code 23

DRB-II displays INTAKE AIR TEMPERATURE SENSOR VOLTAGE HIGH. Condition is: Intake Air Temperature (IAT) sensor input more than maximum acceptable voltage.

Code 24

DRB-II displays THROTTLE POSITION SENSOR VOLTAGE LOW. Condition is: Throttle Position Sensor (TPS) input less than minimum acceptable voltage.

Code 24

DRB-II displays THROTTLE POSITION SENSOR VOLTAGE HIGH. Condition is: Throttle Position Sensor (TPS) input more than maximum acceptable voltage.

Code 25

DRB-II displays IDLE AIR CONTROL MOTOR CIRCUITS. Condition is: open or shorted condition detected in one or more Idle Air Control (IAC) motor circuits.

Code 27

DRB-II displays INJECTOR #1-6 CONTROL CIRCUIT. Condition is: injector output driver does not respond properly to Powertrain Control Module (PCM) control signal.

Code 33

DRB-II displays A/C CLUTCH RELAY CIRCUIT. Condition is: open or shorted condition detected in A/C clutch relay circuit.

Code 34

DRB-II displays SPEED CONTROL SOLENOID CIRCUITS. Condition is: open or shorted condition detected in Speed Control (S/C) vacuum or vent solenoid circuits.

Code 35

DRB-II displays RADIATOR FAN RELAY CIRCUIT. Condition is: open or shorted condition detected in radiator fan relay circuit.

Code 41

DRB-II displays GENERATOR FIELD NOT SWITCHING PROPERLY. Condition is: open or shorted condition detected in alternator field

circuit.

Code 42

DRB-II displays AUTO SHUTDOWN RELAY CONTROL CIRCUIT.  
Condition is: open or shorted condition detected in Auto Shutdown (ASD) relay circuit.

Code 42

DRB-II displays NO ASD RELAY VOLTAGE SENSE AT PCM. Condition is: Powertrain Control Module (PCM) did not receive message in Auto Shutdown (ASD) relay circuit.

Code 44

DRB-II displays BATTERY TEMP SENSOR VOLTS OUT OF LIMIT.  
Condition is: Powertrain Control Module (PCM) failure.

Code 46

DRB-II displays CHARGING SYSTEM VOLTAGE TOO HIGH. Condition is: battery voltage sense input more than target charging voltage during engine operation.

Code 47

DRB-II displays CHARGING SYSTEM VOLTAGE TOO LOW. Condition is: battery voltage sense input less than target charging voltage during engine operation.

Code 51

DRB-II displays O2S STAYS BELOW CENTER (LEAN). Condition is: oxygen sensor input indicates lean air/fuel ratio during engine operation.

Code 52

DRB-II displays O2S STAYS ABOVE CENTER (RICH). Condition is: oxygen sensor input indicates rich air/fuel ratio during engine operation.

Code 53

DRB-II displays INTERNAL PCM FAILURE. Condition is: Powertrain Control Module (PCM) detects internal failure.

Code 53

DRB-II displays PCM FAILURE SPI COMMUNICATION. Condition is: No CCD bus communication.

Code 54

DRB-II displays NO CAM SYNC SIGNAL AT PCM. Condition is: open or shorted condition detected in cam sync signal circuit.

Code 55

DRB-II display will be blank. Completion of fault code display by CHECK ENGINE light.

Code 62

DRB-II displays PCM FAILURE SRI MILE NOT STORED. Condition is: Powertrain Control Module (PCM) detects internal failure.

Code 63

DRB-II displays PCM FAILURE EEPROM WRITE DENIED. Condition is: unsuccessful attempt to write to an EEPROM location by PCM.

Code 76

DRB-II displays FUEL PUMP RESISTOR BY-PASS RELAY CIRCUIT.  
Condition is: open or shorted condition detected in ballast resistor

by-pass relay circuit.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION Section before disconnecting battery.

CONNECTOR IDENTIFICATION

CONNECTOR IDENTIFICATION DIRECTORY TABLE

Connector	See Fig.
Idle Air Control (IAC) Motor .....	4
Coolant Temperature Sensor .....	5
Camshaft & Crankshaft Position Sensor .....	6
Engine Controller .....	7
Engine Diagnostic .....	8
Fuel Injector .....	9
Ignition Coil .....	10
Manifold Absolute Pressure (MAP) Sensor .....	11
Oxygen (O2) Sensor .....	12
Relays .....	13
Throttle Position Sensor .....	14
Fuel Pump Relay Test .....	15

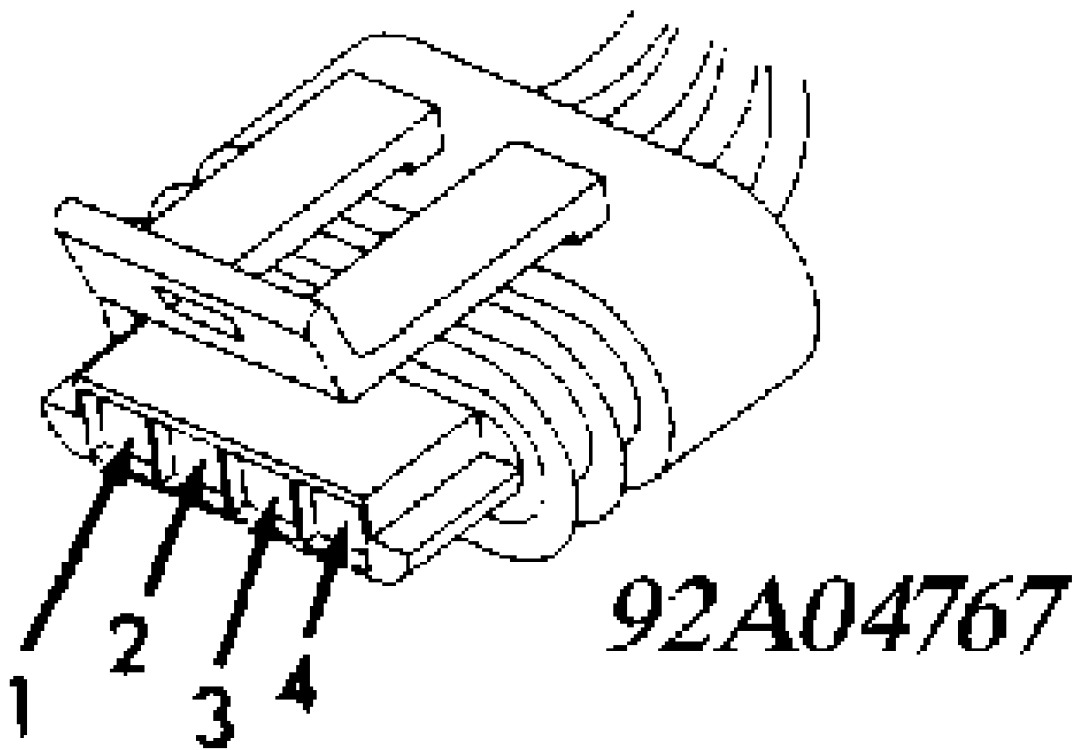


Fig. 4: Identifying Idle Air Control (IAC) Motor Connector Terminals  
Courtesy of Chrysler Corp.

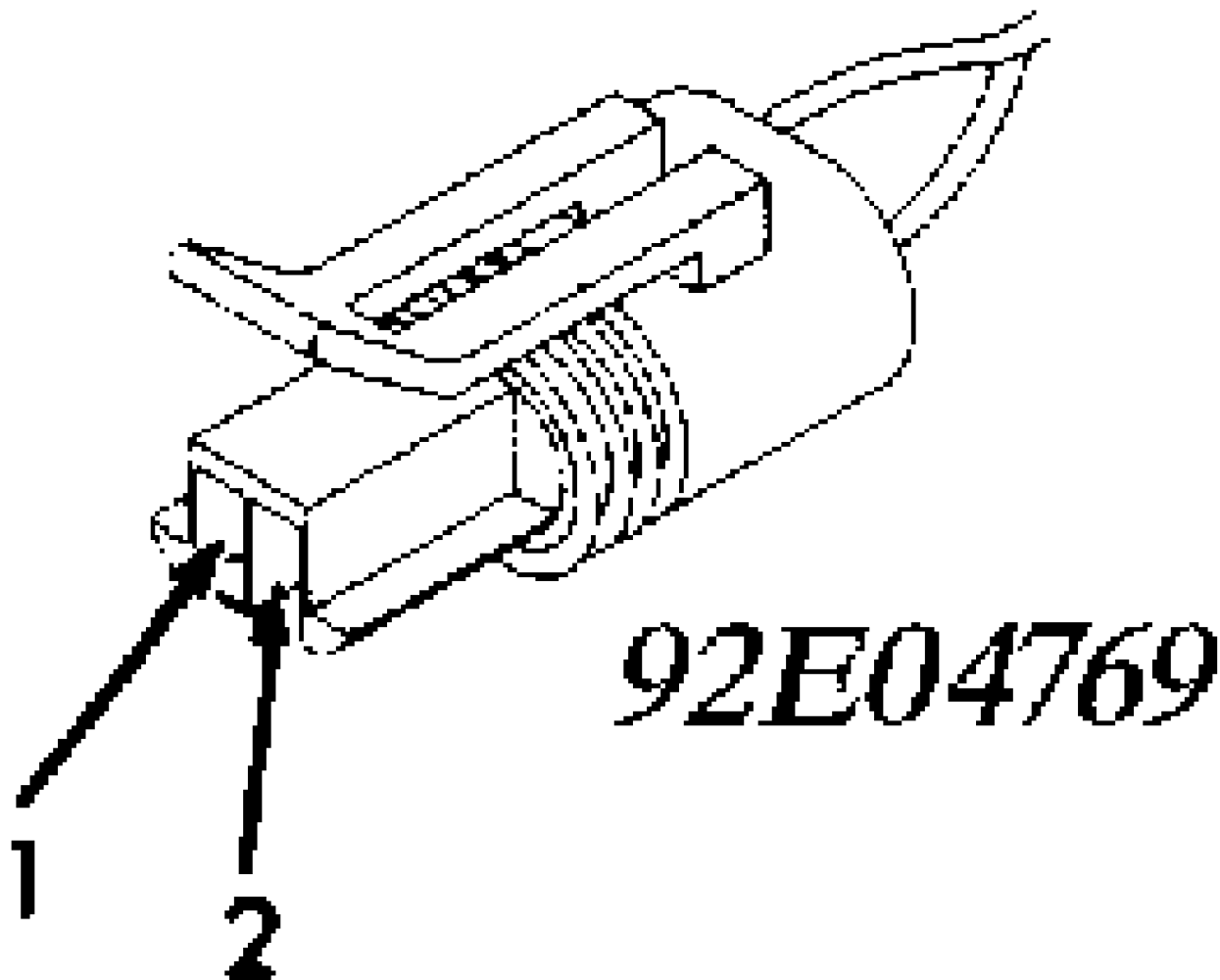


Fig. 5: Identifying Coolant Temperature Sensor Connector Terminals  
 Courtesy of Chrysler Corp.

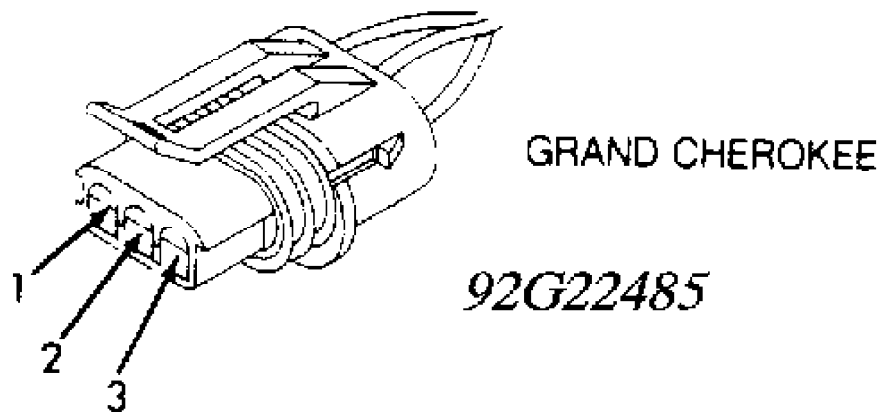


Fig. 6: Camshaft & Crankshaft Position Sensor Connector Terminal ID  
 Courtesy of Chrysler Corp.

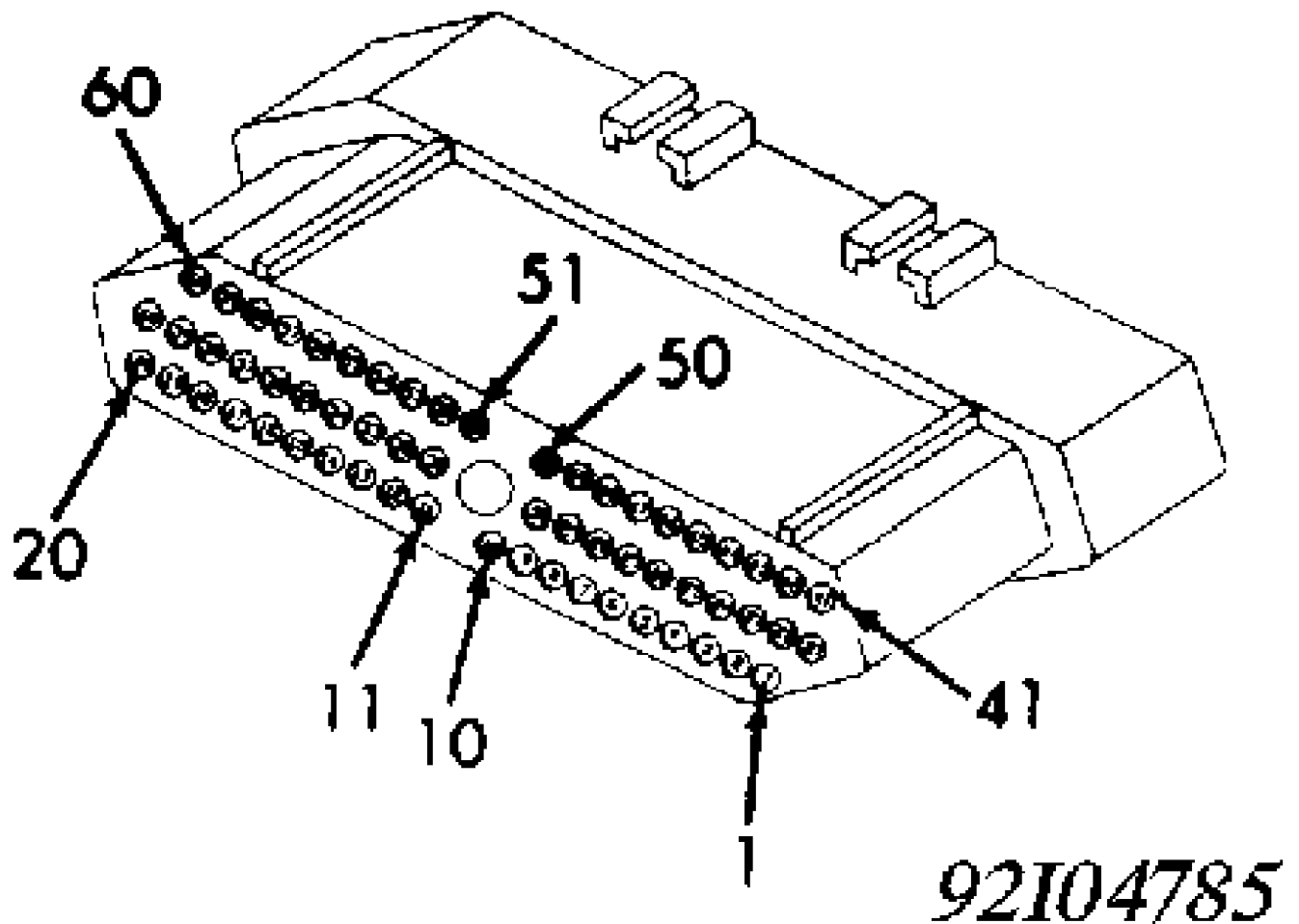
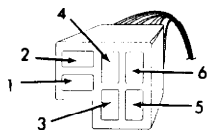


Fig. 7: Identifying Engine Controller Connector Terminals  
Courtesy of Chrysler Corp.



#### ENGINE DIAGNOSTIC CONNECTOR TERMINAL IDENTIFICATION

Cavity & Model	Wire Color
No. 1	
Cherokee (XJ) .....	Black/White
Grand Cherokee (ZJ) .....	Black/Tan
Wrangler (YJ) .....	Black/White
No. 2 .....	Not Used
No. 3	
Cherokee (XJ) .....	Pink
Grand Cherokee (ZJ) .....	Black
Wrangler (YJ) .....	Pink
No. 4	
Cherokee (XJ) .....	Light Green
Grand Cherokee (ZJ) .....	Black/Yellow
Wrangler (YJ) .....	Light Green
No. 5	
Cherokee (XJ) .....	Dark Blue/White
Grand Cherokee (ZJ) .....	Light Blue/Red
Wrangler (YJ) .....	White/Yellow
No. 6 .....	Not Used

93A76216  
Fig. 8: Identifying Engine Diagnostic Connector Terminals  
Courtesy of Chrysler Corp.

ENGINE DIAGNOSTIC CONNECTOR TERMINAL IDENTIFICATION

Cavity & Model	Wire Color
No. 1	
Cherokee (XJ) .....	Black/White
Grand Cherokee (ZJ) .....	Black/Tan
Wrangler (YJ) .....	Black/White
No. 2 .....	Not Used
No. 3	
Cherokee (XJ) .....	Pink
Grand Cherokee (ZJ) .....	Black
Wrangler (YJ) .....	Pink
No. 4	
Cherokee (XJ) .....	Light Green
Grand Cherokee (ZJ) .....	Black/Yellow
Wrangler (YJ) .....	Light Green
No. 5	
Cherokee (XJ) .....	Dark Blue/White
Grand Cherokee (ZJ) .....	Light Blue/Red
Wrangler (YJ) .....	White/Yellow
No. 6 .....	Not Used

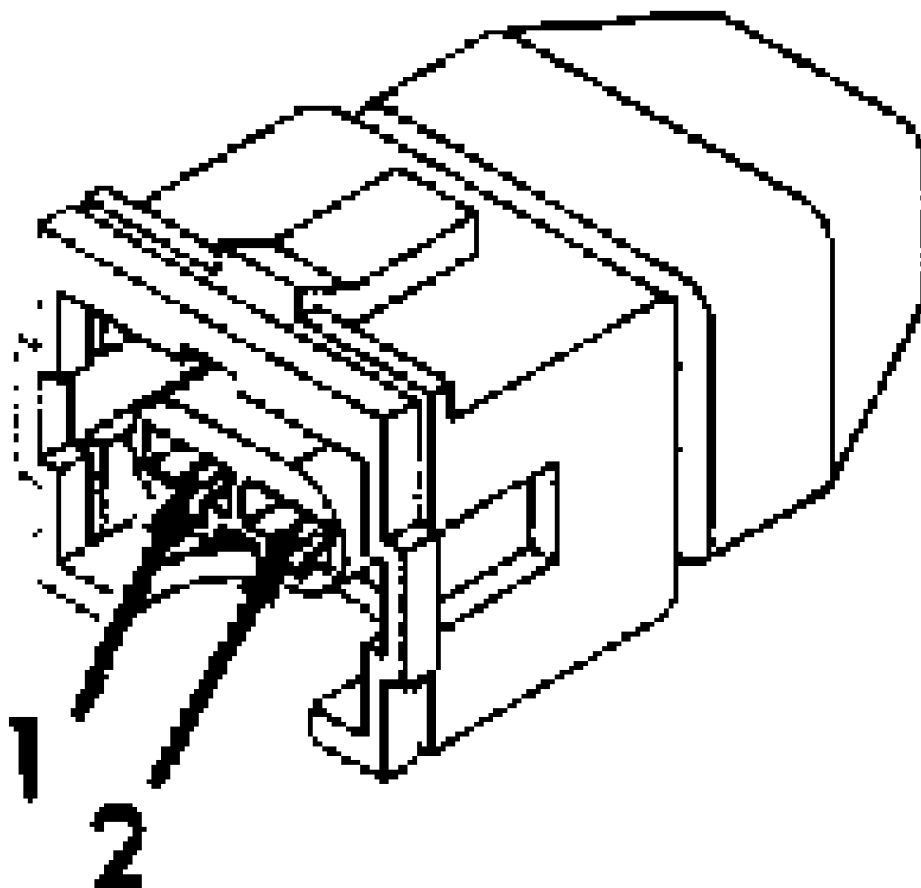


Fig. 9: Identifying Fuel Injector Connector Terminals  
 Courtesy of Chrysler Corp.

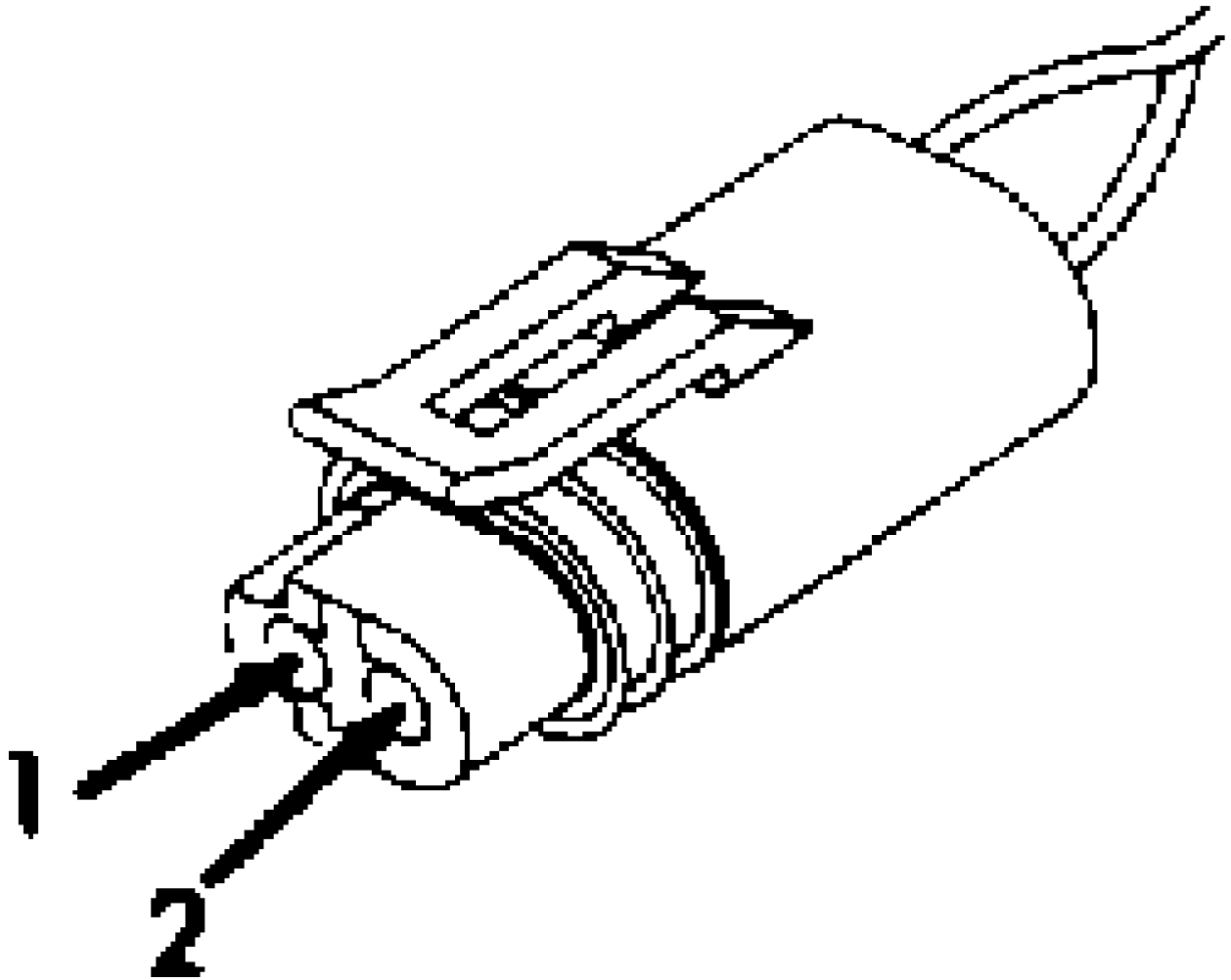
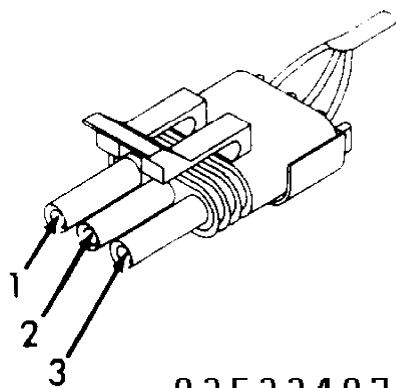
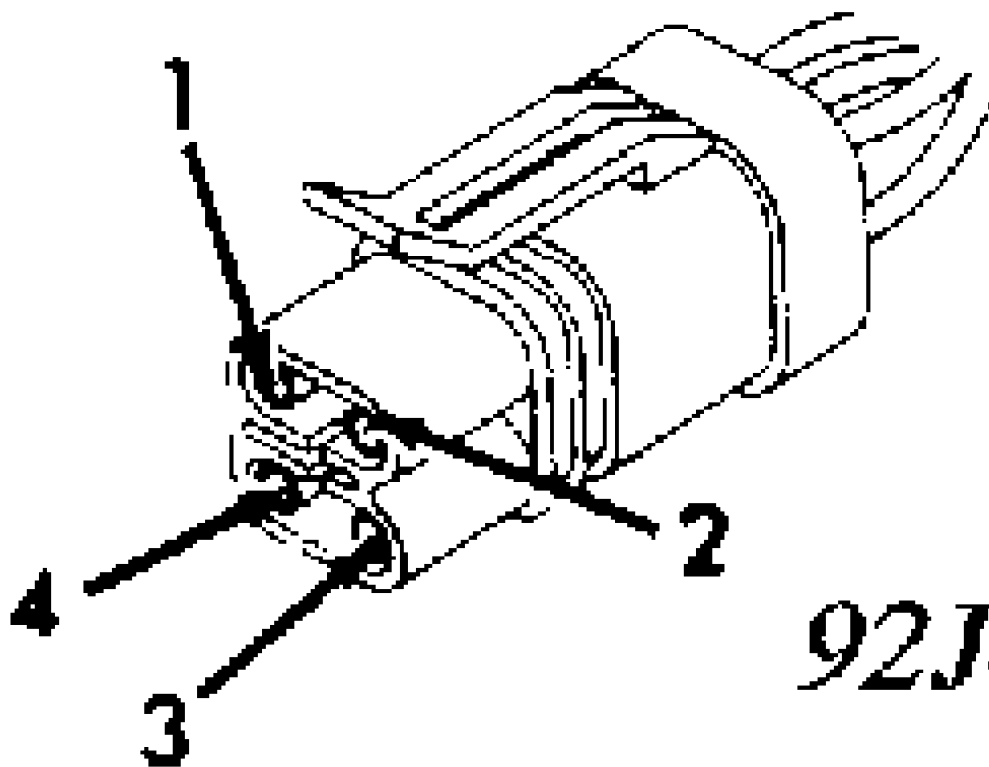


Fig. 10: Identifying Ignition Coil Connector Terminals  
 Courtesy of Chrysler Corp.



92E22487

Fig. 11: Manifold Absolute Pressure (MAP) Sensor Connector Term. ID  
 Courtesy of Chrysler Corp.



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Fig. 12: Identifying Oxygen (O2) Sensor Connector Terminals  
 Courtesy of Chrysler Corp.

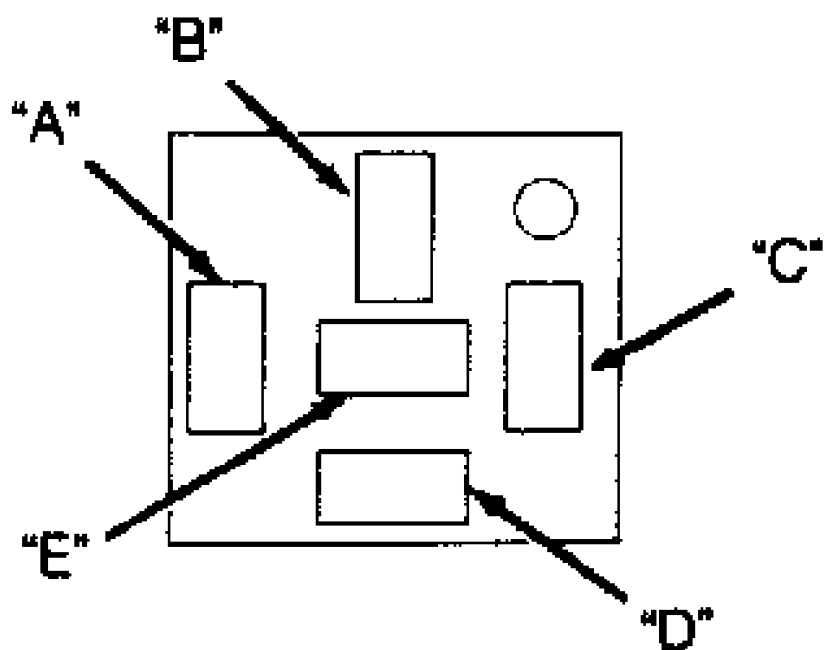
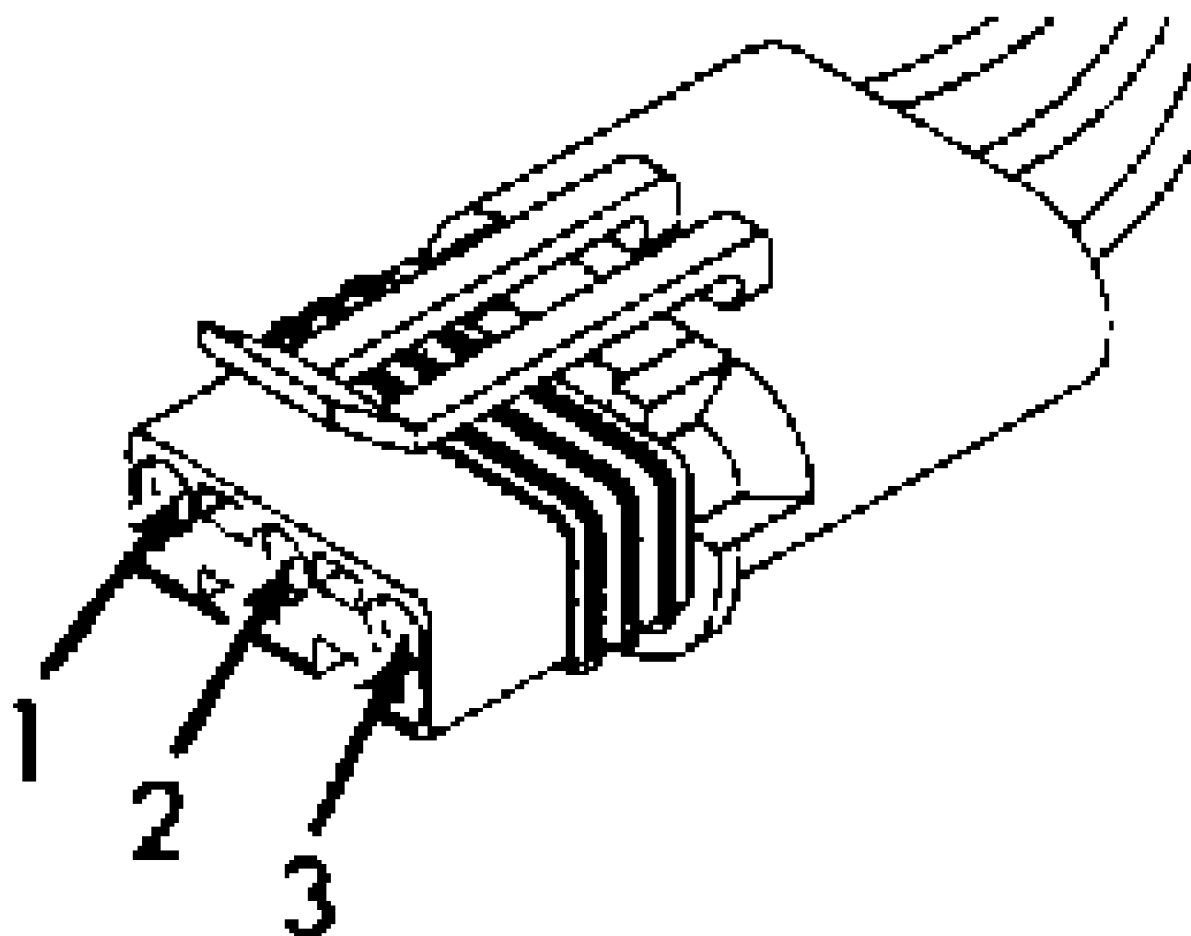


Fig. 13: Identifying Relay Connector Terminals  
 Courtesy of Chrysler Corp.





*92C04787*

Fig. 14: Identifying Throttle Position Sensor Connector Terminals  
Courtesy of Chrysler Corp.

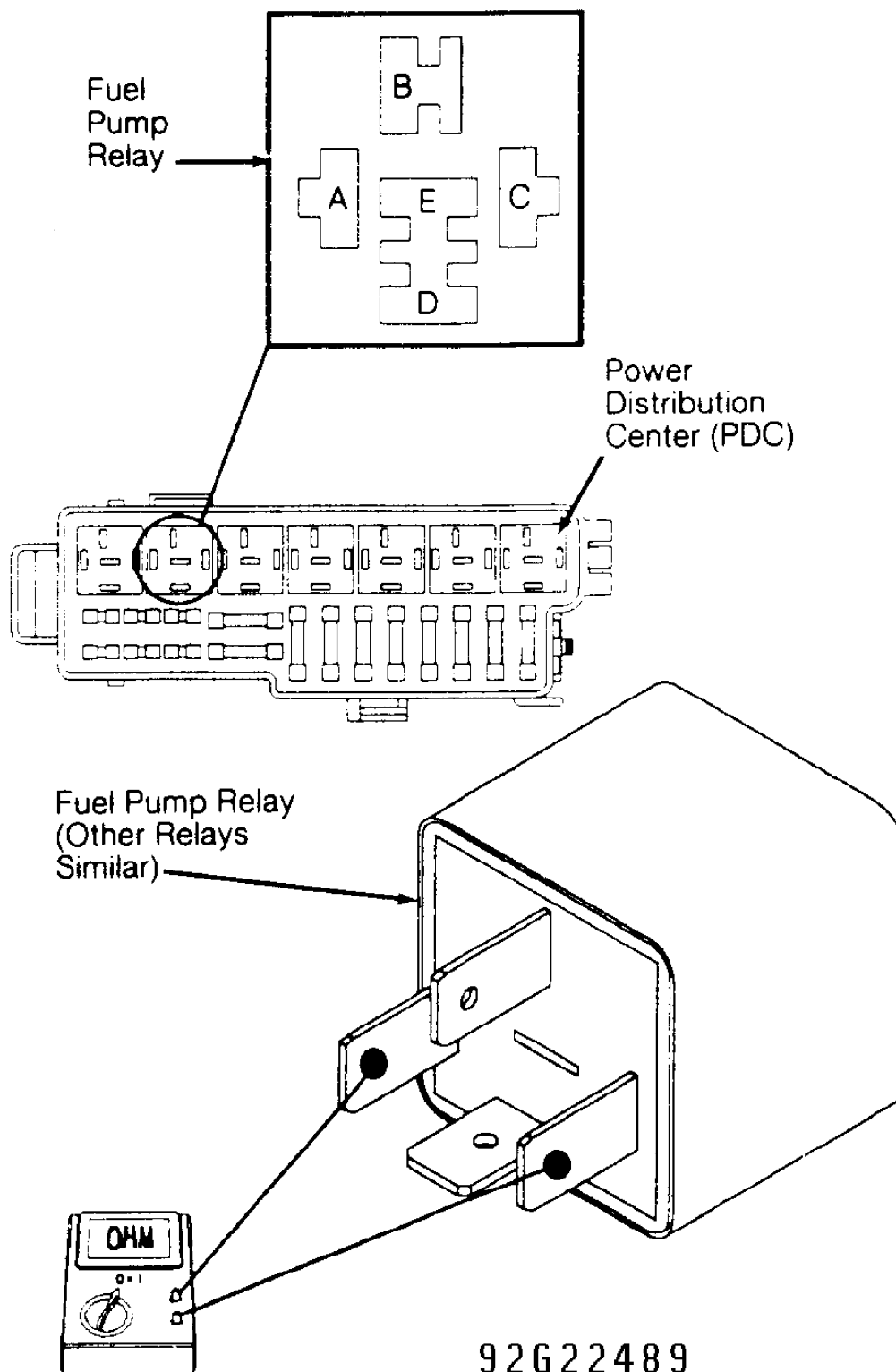


Fig. 15: Testing Fuel Pump Relay  
Courtesy of Chrysler Corp.

## SELF-DIAGNOSTIC TESTS

NOTE: For Grand Cherokee with 5.2L engine, see G - 5.2L TESTS W/  
CODES article in the ENGINE PERFORMANCE Section.

## TEST FC-1A - CHECKING FOR FAULTS

NOTE: For connector terminal identification, see CONNECTOR  
IDENTIFICATION at beginning of article. For wiring diagrams,  
see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE  
Section.

1) Battery must be fully charged before proceeding. Attempt  
to start engine. If engine will not start, crank engine for at least  
10 seconds. Connect DRB-II to engine diagnostic connector. Record DRB-  
II fault messages.

2) If DRB-II has a blank screen or displays RAM TEST FAILURE,  
CARTRIDGE ERROR, KEY PAD TEST FAILURE, or LOW OR HIGH BATTERY, DRB-II  
failure is indicated. To diagnose and correct, see G - BODY TESTS W/  
CODES article in the ENGINE PERFORMANCE Section.

3) If DRB-II displays NO RESPONSE, go to TEST NS-6A. If fault  
messages are displayed, see DRB-II FAULT MESSAGES table. If no fault  
messages are displayed and a driveability problem is present, go to  
TEST NF-1A. If no fault messages are displayed and a no-start problem  
is present, go to TEST NS-1A.

### DRB-II FAULT MESSAGES TABLE

DRB-II Message	Test No.
NO CRANK REFERENCE SIGNAL AT PCM .....	FC-2A
NO CAM SYNC SIGNAL AT PCM .....	FC-3A
NO CHANGE IN MAP FROM START TO RUN .....	FC-4A
MAP SENSOR VOLTAGE TOO LOW .....	FC-5A
MAP SENSOR VOLTAGE TOO HIGH .....	FC-6A
NO VEHICLE SPEED SENSOR SIGNAL .....	FC-7A
O2S STAYS AT CENTER .....	FC-8A
O2S SHORTED TO VOLTAGE .....	FC-9A
O2S STAYS ABOVE CENTER (RICH) .....	FC-10A
O2S STAYS BELOW CENTER (LEAN) .....	FC-11A
ECT SENSOR VOLTAGE TOO HIGH .....	FC-12A
ECT SENSOR VOLTAGE TOO LOW .....	FC-13A
INTAKE AIR TEMP SENSOR VOLTAGE LOW .....	FC-14A
INTAKE AIR TEMP SENSOR VOLTAGE HIGH .....	FC-15A
THROTTLE POSITION SENSOR VOLTAGE HIGH .....	FC-16A
THROTTLE POSITION SENSOR VOLTAGE LOW .....	FC-17A
IDLE AIR CONTROL MOTOR CIRCUITS .....	FC-18A
INJECTOR #1 CONTROL CIRCUIT .....	FC-19A
INJECTOR #2 CONTROL CIRCUIT .....	FC-20A
INJECTOR #3 CONTROL CIRCUIT .....	FC-21A
INJECTOR #4 CONTROL CIRCUIT .....	FC-22A
INJECTOR #5 CONTROL CIRCUIT .....	FC-23A
INJECTOR #6 CONTROL CIRCUIT .....	FC-24A
A/C CLUTCH RELAY CIRCUIT .....	FC-25A
RAD FAN CONTROL RELAY CIRCUIT .....	FC-26A
AUTO SHUTDOWN RELAY CONTROL CIRCUIT .....	FC-27A
NO ASD RELAY VOLT SENSE AT PCM .....	FC-28A
PCM FAILURE SRI MILE NOT STORED .....	FC-29A
PCM FAILURE EEPROM WRITE DENIED .....	FC-30A
FUEL PUMP RESISTOR BYPASS RELAY CIRCUIT .....	FC-31A
CHARGING SYSTEM VOLTAGE TOO LOW .....	(1)
CHARGING SYSTEM VOLTAGE TOO HIGH .....	(1)
GENERATOR FIELD NOT SWITCHING PROPERLY .....	(1)
ENGINE IS COLD TOO LONG .....	(2)

INTERNAL PCM FAILURE .....	(3)
SPEED CONTROL SOLENOID CIRCUITS .....	(4)

- (1) - See ALTERNATORS article in the ELECTRICAL Section.
  - (2) - Check cooling system if engine temperature does not reach 176°F (80°C) after driving 20 minutes. This code may set in error during very cold slow speed driving.
  - (3) - Replace PCM and perform TEST VER-1.
  - (4) - See CRUISE CONTROL SYSTEMS article the in ACCESSORIES/SAFETY EQUIPMENT Section.
- 

## TEST FC-2A - NO CRANK REFERENCE SIGNAL AT PCM

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of this article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If DRB-II does not display NO CRANK REFERENCE SIGNAL AT PCM, condition required to set fault is not present at this time. Go to next step. If DRB-II displays NO CRANK REFERENCE SIGNAL AT PCM, go to step 6).

3) NO CRANK REFERENCE SIGNAL AT PCM fault sets if Powertrain Control Module (PCM) does not see a Crankshaft Position (CKP) sensor signal with Camshaft Position (CMP) sensor signal present. Possible causes are: failed CKP sensor, open or shorted CKP sensor signal circuit (Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body), open or shorted CKP sensor 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body), open CKP sensor ground circuit (Black/Light Blue wire), improperly adjusted CKP sensor or failed Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

5) Start engine. Wiggle wiring harness from CKP sensor to Powertrain Control Module (PCM). If engine misfires or stalls, repair wiring harness as necessary. Perform TEST VER-1. If engine does not misfire or stall, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

6) Turn ignition off. Disconnect Crankshaft Position (CKP) sensor connector. Using DRB-II in ohmmeter mode, check resistance of CKP sensor connector, 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body). If resistance is less than 5 ohms, repair short to ground in Orange wire on XJ and YJ bodies or White/Black wire on ZJ body.

7) If resistance is more than 5 ohms, turn ignition on. Using DRB-II in voltmeter mode, check voltage on CKP sensor connector, 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body). If voltage is less than 7 volts, go to TEST FC-2B. If voltage is more than 7 volts, turn ignition off.

8) Connect a jumper wire between signal circuit (Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body) and ground circuit (Black/Light Blue wire) on CKP sensor connector harness side. Using DRB-II, read fault messages. Make and break connection at CKP sensor connector several times while observing DRB-II.

9) If DRB-II displays NO CAM SYNC SIGNAL AT PCM, replace CKP sensor. Perform TEST VER-1. If DRB-II does not display NO CAM SYNC SIGNAL AT PCM, turn ignition off.

10) Using DRB-II in ohmmeter mode, check resistance on CKP sensor connector, ground circuit (Black/Light Blue wire). If

resistance is more than 5 ohms, repair open in Black/Light Blue wire. Perform TEST VER-1.

11) If resistance is less than 5 ohms, disconnect PCM connector. Inspect PCM sensor connector for damaged or pushed-out terminals. Repair as necessary. Perform TEST VER-1. If PCM connector terminals are okay, go to next step.

12) Using an external ohmmeter, check resistance of signal circuit (Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body) between CKP sensor connector harness side and PCM connector terminal No. 24. If resistance is more than 5 ohms, repair open in Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body. Perform TEST VER-1.

13) If resistance is less than 5 ohms, put DRB-II in ohmmeter mode. Using DRB-II, check resistance of CKP signal circuit (Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body) on PCM connector terminal No. 24. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

14) If resistance is less than 5 ohms, disconnect Camshaft Position (CMP) sensor connector. Using DRB-II, check resistance of CKP signal circuit (Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body) on PCM connector terminal No. 24. If resistance is less more than 5 ohms, replace CMP sensor. Perform TEST VER-1.

15) If resistance is less than 5 ohms, disconnect Vehicle Speed Sensor (VSS) connector. Using DRB-II, check resistance of CKP signal circuit (Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body) on PCM connector terminal No. 24. If resistance is more than 5 ohms, replace Vehicle Speed Sensor (VSS). Perform TEST VER-1. If resistance is less than 5 ohms, repair short to ground in Gray/Black wire on XJ and YJ bodies or Red/Light Green wire on ZJ body. Perform TEST VER-1.

## TEST FC-2B - NO CRANK REFERENCE SIGNAL AT PCM

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Inspect PCM connector for damaged or pushed-out terminals. Repair as necessary. Perform TEST VER-1. If PCM connector terminals are okay, go to next step.

2) Using an external ohmmeter, check resistance of 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body) between CKP sensor connector harness side and PCM connector terminal No. 7. If resistance is more than 5 ohms, repair open in Orange wire on XJ and YJ bodies or White/Black wire on ZJ body. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-3A - NO CAM SYNC SIGNAL AT PCM

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If DRB-II does not display NO CAM SYNC SIGNAL AT PCM, condition required to set fault is not present at this time. Go to next step. If DRB-II displays NO CAM

SYCN SIGNAL AT PCM, go to step 5).

3) NO CAM SYNC SIGNAL AT PCM fault sets if Powertrain Control Module does not see Camshaft Position (CMP) sensor signal with Crankshaft Position (CKP) signal present. Possible causes are: failed CMP sensor, open or shorted CMP sensor signal circuit (Tan/Yellow wire on XJ and YJ bodies or Gray/Black wire on ZL body), open CMP sensor 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body), open CMP sensor ground circuit (Black/Light Blue wire), improperly adjusted CMP sensor or failed Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring or connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1. Go to next step.

5) Turn ignition off. Disconnect Camshaft Position (CMP) sensor connector. Using DRB-II in ohmmeter mode, check resistance of CMP sensor connector, 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body). If resistance is less than 5 ohms, repair short to ground in Orange wire on XJ and YJ bodies or White/Black wire on ZJ body. Perform TEST VER-1.

6) If resistance is more than 5 ohms, turn ignition on. Using DRB-II in voltmeter mode, check voltage on CMP sensor connector, 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body). If voltage is less than 7 volts, go to TEST FC-3B.

7) If voltage is more than 7 volts, turn ignition off. Connect a jumper wire between signal circuit (Tan/Yellow wire on XJ and YJ bodies or Gray/Black wire on ZJ body) and ground circuit (Black/Light Blue wire) on CKP sensor connector harness side. Make and break connection at CKP sensor connector several times.

8) Attempt to start engine. If engine starts, replace CMP sensor. Perform TEST VER-1. If engine does not start, turn ignition off.

9) Using DRB-II in ohmmeter mode, check resistance on CMP sensor connector, ground circuit (Black/Light Blue wire). If resistance is more than 5 ohms, repair open in Black/Light Blue wire. Perform TEST VER-1.

10) If resistance is less than 5 ohms, disconnect Powertrain Control Module (PCM) connector. Inspect PCM connector for damaged or pushed-out terminals. Repair as necessary. Perform TEST VER-1. If PCM connector terminals are okay, go to next step.

11) Using an external ohmmeter, check resistance of signal circuit (Tan/Yellow wire on XJ and YJ bodies or Gray/Black on ZJ body) between CMP sensor connector harness side and PCM connector terminal No. 44. If resistance is more than 5 ohms, repair open in Tan/Yellow wire on XJ and YJ bodies or Gray/Black on ZJ body. Perform TEST VER-1.

12) If resistance is less than 5 ohms, using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 44. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is less than 5 ohms, repair short to ground in Tan/Yellow wire on XJ and YJ bodies or Gray/Black wire on ZJ body. Perform TEST VER-1.

## TEST FC-3B - NO CAM SYNC SIGNAL AT PCM

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Inspect PCM connector for damaged or pushed-out terminals. Repair as necessary. Perform TEST VER-1. If PCM connector terminals are okay, go to next step.

2) Using an external ohmmeter, check resistance of 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body) between CMP sensor connector harness side and PCM connector terminal No. 7. If resistance is more than 5 ohms, repair open in Orange wire on XJ and YJ bodies or White/Black wire on ZJ body. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-4A - NO CHANGE IN MAP FROM START TO RUN

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition on. Using DRB-II, erase fault messages. Start engine. Allow engine to idle for 30 seconds. With engine running, read fault messages using DRB-II. If DRB-II does not display NO CHANGE IN MAP FROM START TO RUN, go to step 4).

2) If DRB-II displays NO CHANGE IN MAP FROM START TO RUN, turn ignition off. Disconnect Manifold Absolute Pressure (MAP) sensor connector. Turn ignition on. Using DRB-II in voltmeter mode, check voltage on MAP sensor connector, 5-volt supply circuit (Violet/White wire).

3) If voltage is less than 4 volts, repair open or short in Violet/White wire. Perform TEST VER-1. If voltage is more than 4 volts, remove MAP sensor vacuum hose. Inspect condition of MAP sensor vacuum hose. If MAP sensor vacuum hose is restricted or open, replace vacuum hose as necessary. Perform TEST VER-1. If MAP sensor vacuum hose is okay, replace MAP sensor. Perform TEST VER-1.

4) Using DRB-II, set engine speed to 1500 RPM. With engine running at 1500 RPM, read DRB-II MAP sensor voltage. While monitoring MAP sensor voltage, wiggle MAP sensor connector and wiring harness.

5) If engine stalls or MAP sensor voltage becomes erratic, inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If engine does not stall and MAP sensor voltage does not become erratic, snap throttle open and closed while monitoring DRB-II.

6) If engine vacuum does not rapidly drop to less than one in. Hg, go to step 8). If engine vacuum rapidly drops to less than one in. Hg, condition required to set fault is not present at this time. Go to next step.

7) NO CHANGE IN MAP FROM START TO RUN fault sets if too small a difference is seen between barometric pressure at key on and manifold vacuum after engine start. Possible causes are: restricted or leaking vacuum/pressure hose to MAP sensor, ice in MAP sensor or passage, or MAP sensor failure. Perform TEST VER-1.

8) Remove MAP sensor vacuum hose. Inspect condition of MAP sensor vacuum hose. If MAP sensor vacuum hose is restricted or open, replace vacuum hose as necessary. Perform TEST VER-1. If MAP sensor vacuum hose is okay, replace MAP sensor. Perform TEST VER-1.

## TEST FC-5A - MAP SENSOR VOLTAGE TOO LOW

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Start engine. Using DRB-II, read Manifold Absolute Pressure (MAP) sensor voltage. If MAP sensor voltage is less than .2 volt, go to step 5). If MAP sensor voltage is more than .2 volt, turn engine off. Turn ignition on.

2) Using DRB-II, read MAP sensor voltage. If voltage is less than 1.2 volts, go to step 5). If voltage is more than 1.2 volts, wiggle MAP sensor connector and wiring harness while watching DRB-II display. If MAP sensor voltage changes, repair connector or wiring harness as necessary. Perform TEST VER-1.

3) If MAP sensor voltage does not change, condition required to set fault is not present at this time. MAP SENSOR VOLTAGE TOO LOW fault sets if MAP sensor output is less than 1.2 volts at start or less than .2 volt with engine running. Engine speed must be more than 400 RPM, but less than 1500 RPM, and Throttle Position Sensor (TPS) voltage must be less than one volt. Possible causes are: short to ground in MAP sensor signal circuit (Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body), MAP sensor shorted internally or loss of MAP sensor 5-volt supply circuit (Violet/White wire). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

5) Turn ignition on. Ensure engine is off. Disconnect MAP sensor connector. Using DRB-II, read MAP sensor voltage. If MAP sensor voltage is more than 4 volts, replace MAP sensor. Perform TEST VER-1.

6) If MAP sensor voltage is less than 4 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance between signal circuit (Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body) and ground circuit (Black/Light Blue wire) on MAP sensor connector. If resistance is less than 5 ohms, repair short to ground in Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-6A - MAP SENSOR VOLTAGE TOO HIGH

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Start engine. Using DRB-II, read Manifold Absolute Pressure (MAP) sensor voltage. If MAP sensor voltage is more than 4.6 volts, go to step 4). If MAP sensor voltage is less than 4.6 volts, wiggle MAP sensor connector and wiring harness while watching DRB-II display. If MAP sensor voltage changes, repair connector or wiring harness as necessary. Perform TEST VER-1.

2) If MAP sensor voltage does not change, condition required to set fault is not present at this time. MAP SENSOR VOLTAGE TOO HIGH fault sets if MAP sensor output is more than 4.6 volts at start or with engine running. Engine speed must be more than 400 RPM but less than 1500 RPM, and Throttle Position Sensor (TPS) voltage must be less than one volt. Possible causes are: open MAP sensor signal circuit (Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body), MAP sensor open internally, open MAP sensor ground circuit (Black/Light Blue wire) or short to voltage in MAP sensor signal circuit (Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body). Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Turn ignition on. Ensure engine is off. Disconnect MAP sensor connector. Connect a jumper wire between signal circuit (Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body) and ground circuit (Black/Light Blue wire) on MAP sensor connector. Using DRB-II, read MAP sensor voltage. If voltage is less than one volt,



replace MAP sensor. Perform TEST VER-1.

5) If MAP sensor voltage is more than one volt, move jumper wire from MAP sensor connector, ground circuit (Black/Light Blue wire) to an engine ground. Using DRB-II, read MAP sensor voltage.

6) If MAP sensor voltage is less than one volt, repair open in Black/Light Blue wire. Perform TEST VER-1. If MAP sensor voltage is more than one volt, turn ignition off. Disconnect Powertrain Control Module (PCM) connector.

7) Using an external ohmmeter, check resistance of signal circuit (Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body) between MAP sensor connector and PCM connector terminal No. 1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in Dark Green/Red wire on XJ and YJ bodies or Red/White wire on ZJ body. Perform TEST VER-1.

## TEST FC-7A - NO VEHICLE SPEED SENSOR SIGNAL

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Raise vehicle so drive wheels are free to spin. Start engine. Using DRB-II, read Vehicle Speed Sensor (VSS) signal. Put transmission in any forward gear. If DRB-II displays more than zero MPH, go to next step. If DRB-II does not display more than zero MPH, go to step 4).

2) Condition required to set fault is not present at this time. NO VEHICLE SPEED SENSOR SIGNAL fault sets if Powertrain Control Module (PCM) does not see a VSS signal at PCM terminal No. 47 (White/Orange wire) under road load conditions. Possible causes are: open or shorted VSS signal circuit (White/Orange wire), open VSS sensor 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body), open VSS sensor ground circuit (Black/Light Blue wire), failed VSS sensor, failed Daytime Running Light (DRL) module (if equipped) or failed Powertrain Control Module (PCM). Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Turn ignition off. Disconnect Vehicle Speed Sensor (VSS) connector. Turn ignition on. Using DRB-II in voltmeter mode, check voltage on VSS sensor connector, 8-volt supply circuit (Orange wire on XJ and YJ bodies or White/Black wire on ZJ body). If voltage is more than 7 volts, go to next step. If voltage is less than 7 volts, repair open in Orange wire on XJ and YJ bodies or White/Black wire on ZJ body. Perform TEST VER-1.

5) Using DRB-II, check voltage on VSS sensor connector, signal circuit (White/Orange wire). If voltage is less than 4 volts, go to TEST FC-7B. If voltage is more than 4 volts, turn ignition off. Connect a jumper wire between VSS signal circuit (White/Orange wire) and ground circuit (Black/Light Blue wire) on VSS sensor connector.

6) Turn ignition on. Using DRB-II, read vehicle speed. Make and break connection at VSS sensor connector several times while observing DRB-II display. If DRB-II displays vehicle speed as more than zero MPH, replace VSS. Perform TEST VER-1. If DRB-II does not display more than zero MPH, turn ignition off. Using DRB-II in ohmmeter mode, check resistance on VSS sensor connector, ground circuit (Black/Light Blue wire). If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Black/Light Blue wire. Perform TEST VER-1.

7) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of

signal circuit (White/Orange wire) between VSS connector harness side and PCM connector terminal No. 47. If resistance is more than 5 ohms, repair open in White/Orange wire. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-7B - NO VEHICLE SPEED SENSOR SIGNAL

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Inspect PCM connector for damaged or pushed-out terminals. Repair as necessary. Perform TEST VER-1. If no problems were found with wiring or connectors, go to next step.

2) Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 47 (White/Orange wire). If resistance is more than 5 ohms, go to step 4). If resistance is less than 5 ohms, disconnect Daytime Running Lights (DRL) module connector (if equipped). If vehicle is not equipped with DRL, repair short to ground in White/Orange wire. DRL module is located near blower motor on XJ body, near coolant overflow reservoir on YJ body or under Power Distribution Center on ZJ body. Using DRB-II, check resistance of PCM connector terminal No. 47 (White/Orange wire).

3) If resistance is more than 5 ohms, replace DRL module. Perform TEST VER-1. If resistance is less than 5 ohms, repair short to ground in White/Orange wire. Perform TEST VER-1.

4) Using an external ohmmeter, check resistance of signal circuit (White/Orange wire) between VSS sensor connector and PCM connector terminal No. 47. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in White/Orange wire. Perform TEST VER-1.

## TEST FC-8A - OXYGEN (O2) SENSOR STAYS AT CENTER

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Start engine. Allow engine to run until normal operating temperature is reached. Using DRB-II, set engine speed to 1500 RPM. Using DRB-II, read oxygen sensor state. If oxygen sensor is not switching from rich to lean, go to step 4). If oxygen sensor is switching from rich to lean, wiggle sensor connector and wiring harness while watching DRB-II display.

2) If oxygen sensor was locked at center at any time, inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If oxygen sensor was not locked at center at any time, condition required to set fault is not present at this time. O2S STAYS AT CENTER fault sets if oxygen sensor output voltage stays at .5 volt for 1.5 minutes with engine temperature more than 170°F (77°C) and engine running for 2 minutes. Possible causes are: open oxygen sensor circuit or oxygen sensor failure. Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Turn ignition off. Disconnect oxygen sensor connector. Using DRB-II in ohmmeter mode, check resistance of ground circuit (Black/Light Blue wire) at oxygen sensor connector harness side. If resistance is more than 5 ohms, repair open in Black/Light Blue wire. Perform TEST VER-1.

5) If resistance is less than 5 ohms, connect a jumper wire between oxygen sensor signal circuit (Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body) and battery positive terminal. Using DRB-II, read oxygen sensor voltage. If oxygen sensor voltage is more than one volt, replace oxygen sensor. Perform TEST VER-1.

6) If oxygen sensor voltage is less than one volt, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Disconnect jumper wire between oxygen sensor signal circuit (Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body) and battery positive terminal.

7) Using an external ohmmeter, check resistance of signal circuit (Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body) between oxygen sensor connector harness side and PCM connector terminal No. 41. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body. Perform TEST VER-1.

## TEST FC-9A - OXYGEN (O2) SENSOR SHORTED TO VOLTAGE

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read oxygen sensor voltage. If oxygen sensor voltage is more than 1.2 volts, go to step 4). If oxygen sensor voltage is less than 1.2 volts, wiggle oxygen sensor connector and wiring harness while watching DRB-II display. If voltage goes to more than 1.2 volts at any time, repair wiring and connectors as necessary. Perform TEST VER-1.

2) If voltage does not go to more than 1.2 volts at any time, condition required to set fault is not present at this time. O2S SHORTED TO VOLTAGE fault sets if oxygen sensor signal circuit voltage goes to more than 1.2 volts. Possible causes are: oxygen sensor signal circuit (Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body) shorted to another circuit, oxygen sensor connector has excessive dirt, grease and/or water build-up, or oxygen sensor failure. Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Turn ignition off. Disconnect oxygen sensor connector. Using DRB-II in voltmeter mode, read oxygen sensor voltage. If voltage is more than 1.2 volts, repair short to voltage in Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body, on oxygen sensor connector harness side. Perform TEST VER-1. If voltage is less than 1.2 volts, replace oxygen sensor. Perform TEST VER-1.

## TEST FC-10A - OXYGEN (O2) SENSOR STAYS ABOVE CENTER (RICH)

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Start engine. Allow engine to run until normal operating temperature is reached. Using DRB-II, set engine speed to 1500 RPM. Using DRB-II, read oxygen sensor voltage. If oxygen sensor voltage is not always more than .5 volt, condition required to set fault is not present at this time. Go to next step. If oxygen sensor voltage is always more than .5 volt, go to step 3).

2) O2S STAYS ABOVE CENTER (RICH) fault sets if oxygen sensor output voltage stays at more than .5 volt, but less than 1.2 volts, without changing for more than 8 minutes. Possible causes are: high fuel pressure, other engine sensor calibration failures, ignition system failure, oxygen sensor failure or fuel contamination. Go to TEST NF-1A.

3) Using DRB-II, stop all actuation tests. Turn ignition off. Inspect air cleaner filter and inlet ducts for restrictions. If restrictions are present, repair as necessary. Perform TEST VER-1. If restrictions are not present, remove fuel injector rail assembly.

4) Turn ignition on. Using DRB-II, actuate ASD fuel system test. Inspect all injectors for leakage. If injectors are leaking, stop ASD fuel system test. Replace leaking fuel injectors as necessary. Perform TEST VER-1.

5) If injectors are not leaking, using DRB-II, stop ASD fuel system test. A condition causing engine to run rich is present. Return to step 2).

### TEST FC-11A - OXYGEN (O2) SENSOR STAYS BELOW CENTER (LEAN)

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Start engine. Allow engine to run until normal operating temperature is reached. Using DRB-II, set engine speed to 1500 RPM. Using DRB-II, read oxygen sensor voltage. If oxygen sensor voltage is not always less than .5 volt, condition required to set fault is not present at this time. Go to next step. If oxygen sensor voltage is always less than .5 volt, go to step 3).

2) O2S STAYS BELOW CENTER (LEAN) fault sets if oxygen sensor output voltage stays at less than .5 volt without changing for more than 8 minutes. Possible causes are: large vacuum leak, low fuel pressure, other engine sensor calibration failures, ignition system failure, oxygen sensor failure or fuel contamination. Go to TEST NF-1A.

3) Using DRB-II, check if oxygen sensor voltage is always zero volts. If oxygen sensor voltage is always zero volts, go to next step. If oxygen sensor voltage is not always zero volts, a condition causing engine to run lean is present. Go to TEST NF-1A.

4) Using DRB-II, stop all actuation tests. Turn ignition on with engine off. Disconnect oxygen sensor connector. Using DRB-II, read oxygen sensor state. If oxygen sensor state is at center, replace oxygen sensor. Perform TEST VER-1.

5) If oxygen sensor state is not at center, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance of oxygen sensor connector (harness side), signal circuit (Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body).

6) If resistance is less than 5 ohms, repair short to ground in Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

### TEST FC-12A - ECT SENSOR VOLTAGE TOO HIGH

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read Engine Coolant Temperature (ECT) sensor

voltage. If voltage is more than 4.5 volts, go to step 4). If voltage is less than 4.5 volts, while observing DRB-II, wiggle wiring harness from ECT sensor to Powertrain Control Module (PCM). If voltage changes, repair wiring harness as necessary. Perform TEST VER-1.

2) If voltage does not change, condition required to set fault is not present at this time. ECT SENSOR VOLTAGE TOO HIGH fault sets if ECT sensor signal circuit (Tan/Black wire) is more than 4.9 volts. Possible causes are: open ECT sensor signal circuit (Tan/Black wire), ECT sensor open internally or open ECT sensor ground circuit (Black/Light Blue wire). Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Disconnect ECT sensor connector. Connect a jumper wire between signal circuit (Tan/Black wire) and ground circuit (Black/Light Blue wire) on ECT sensor connector. Using DRB-II, read ECT sensor voltage.

5) If voltage is less than one volt, replace ECT sensor. Perform TEST VER-1. If voltage is more than one volt, move jumper wire from ECT sensor connector, ground circuit (Black/Light Blue wire) to an engine ground.

6) Using DRB-II, read ECT sensor voltage. If voltage is less than one volt, repair open in Black/Light Blue wire. Perform TEST VER-1. If voltage is more than one volt, turn ignition off. Disconnect Powertrain Control Module (PCM) connector.

7) Using an external ohmmeter, check resistance of signal circuit (Tan/Black wire) between ECT sensor connector and PCM connector terminal No. 2. If resistance is more than 5 ohms, repair open in Tan/Black wire. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-13A - ECT SENSOR VOLTAGE TOO LOW

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read Engine Coolant Temperature (ECT) sensor voltage. If voltage is less than .5 volt, go to step 4). If voltage is more than .5 volt, wiggle wiring harness from ECT sensor to Powertrain Control Module (PCM) while observing DRB-II. If voltage changes, repair wiring harness as necessary. Perform TEST VER-1.

2) If voltage does not change, condition required to set fault is not present at this time. ECT SENSOR VOLTAGE TOO LOW fault sets if ECT sensor signal circuit (Tan/Black wire) is less than .5 volt. Possible causes are: short to ground in ECT sensor signal circuit (Tan/Black wire) or ECT sensor shorted internally. Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-2.

4) Disconnect ECT sensor connector. Using DRB-II, read ECT sensor voltage. If voltage is more than 4 volts, replace ECT sensor. Perform TEST VER-1. If voltage is less than 4 volts, turn ignition off. Disconnect PCM connector.

5) Put DRB-II in ohmmeter mode. Using DRB-II, check resistance of ECT sensor connector, signal circuit (Tan/Black wire). If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is less than 5 ohms, repair short to ground in Tan/Black wire. Perform TEST VER-1.

## TEST FC-14A - INTAKE AIR TEMP SENSOR VOLTAGE LOW

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read Intake Air Temperature Sensor (IAT) voltage. If IAT voltage is less than .5 volt, go to step 4). If IAT voltage is more than .5 volt, wiggle wiring harness from IAT sensor to Powertrain Control Module (PCM) while observing DRB-II. If voltage changed, repair wiring harness as necessary.

2) If voltage does not change, condition required to set fault is not present at this time. INTAKE AIR TEMP SENSOR VOLTAGE LOW fault sets if IAT signal circuit (Black/Red wire), is less than .5 volt. Possible causes are: short to ground in IAT signal circuit (Black/Red wire) or IAT sensor shorted internally. Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Disconnect IAT sensor connector. Using DRB-II, read IAT sensor voltage. If voltage is more than 4 volts, replace IAT sensor. Perform TEST VER-1. If voltage is less than 4 volts, turn ignition off. Disconnect PCM connector.

5) Using DRB-II in ohmmeter mode, check resistance of IAT sensor connector, signal circuit (Black/Red wire). If resistance is less than 5 ohms, repair short to ground in Black/Red wire. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-15A - INTAKE AIR TEMP SENSOR VOLTAGE HIGH

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read Intake Air Temperature Sensor (IAT) voltage. If IAT voltage is more than 4.5 volts, go to step 4). If IAT voltage is less than 4.5 volts, while observing DRB-II display, wiggle wiring harness from IAT sensor to Powertrain Control Module (PCM). If voltage changed, repair wiring harness as necessary.

2) If voltage does not change, condition required to set fault is not present at this time. INTAKE AIR TEMP SENSOR VOLTAGE HIGH fault sets if IAT signal circuit (Black/Red wire), is more than 4.9 volts. Possible causes are: open IAT signal circuit (Black/Red wire), IAT sensor open internally or open IAT sensor ground circuit (Black/Light Blue wire). Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Disconnect IAT sensor connector. Connect jumper wire between signal circuit (Black/Red wire) and ground circuit (Black/Light Blue wire) on IAT sensor connector. Using DRB-II, read IAT sensor voltage. If voltage is less than one volt, replace IAT sensor. Perform TEST VER-1.

5) If voltage is more than one volt, move jumper wire from IAT sensor connector, ground circuit (Black/Light Blue wire) to an engine ground. Using DRB-II, read IAT sensor voltage. If voltage is less than one volt, repair open in Black/Light Blue wire. If voltage is more than one volt, turn ignition off. Disconnect PCM connector.

6) Using an external ohmmeter, check resistance of signal circuit (Black/Red wire) between IAT sensor connector and PCM connector terminal No. 21. If resistance is more than 5 ohms, repair open in

Black/Red wire. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-16A - THROTTLE POSITION SENSOR VOLTAGE HIGH

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read Throttle Position Sensor (TPS) voltage. If TPS voltage is more than 4.5 volts, go to step 5). If TPS voltage is less than 4.5 volts, while observing DRB-II, slowly open and close throttle.

2) If voltage change is not smooth, replace TPS. Perform TEST VER-1. If voltage change is smooth, while observing DRB-II, wiggle wiring harness from TPS to Powertrain Control Module (PCM). If voltage changes, repair wiring harness as necessary. Perform TEST VER-1.

3) If voltage does not change, condition required to set fault is not present at this time. THROTTLE POSITION SENSOR VOLTAGE HIGH fault sets if TPS signal circuit (Orange/Dark Blue wire) is more than 4.5 volts. Possible causes are: open TPS signal circuit (Orange/Dark Blue wire), open TPS ground circuit (Black/Light Blue wire) or TPS sensor failure. Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

5) Disconnect TPS connector. Connect a jumper wire between TPS signal circuit (Orange/Dark Blue wire) and TPS ground circuit (Black/Light Blue wire) on TPS connector. Using DRB-II, read TPS voltage. If voltage is less than one volt, replace TPS. Perform TEST VER-1.

6) If voltage is more than one volt, move jumper wire from TPS connector, ground circuit (Black/Light Blue wire), to an engine ground. Using DRB-II, read TPS sensor voltage.

7) If TPS sensor voltage is less than one volt, repair open in Black/Light Blue wire. Perform TEST VER-1. If TPS voltage is more than one volt, turn ignition off. Disconnect Powertrain Control Module (PCM) connector.

8) Using an external ohmmeter, check resistance of TPS signal circuit (Orange/Dark Blue wire) between TPS connector and PCM connector terminal No. 22. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in Orange/Dark Blue wire. Perform TEST VER-1.

## TEST FC-17A - THROTTLE POSITION SENSOR VOLTAGE LOW

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read Throttle Position Sensor (TPS) voltage. If TPS voltage is less than .2 volt, go to step 5). If TPS voltage is more than .2 volt, while observing DRB-II, slowly open and close throttle.

2) If voltage change is not smooth, replace TPS. Perform TEST VER-1. If voltage change is smooth, while observing DRB-II, wiggle wiring harness from TPS to Powertrain Control Module (PCM). If voltage changes, repair wiring harness as necessary. Perform TEST VER-1.

3) If voltage does not change, condition required to set fault is not present at this time. THROTTLE POSITION SENSOR VOLTAGE LOW fault sets if TPS signal circuit (Orange/Dark Blue wire) is less

than .2 volt or if vehicle speed is more than 20 MPH, engine speed is more than 1500 RPM and vacuum is less than 2 in. Hg with TPS signal circuit (Orange/Dark Blue wire) less than .5 volt. Possible causes are: short to ground in TPS signal circuit (Orange/Dark Blue wire), TPS sensor failure or open TPS 5-volt supply circuit (Violet/White wire). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

5) Disconnect TPS connector. Using DRB-II, read TPS voltage. If voltage is more than one volt, replace TPS. Perform TEST VER-1. If voltage is less than one volt, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance of TPS connector, signal circuit (Orange/Dark Blue wire).

6) If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is less than 5 ohms, disconnect Transmission Control Module (TCM) connector (if equipped). If vehicle is not equipped with TCM, repair short to ground in Orange/Dark Blue wire. Perform TEST VER-1. On vehicles with TCM, using DRB-II, check resistance of TPS connector, signal circuit (Orange/Dark Blue wire).

7) If resistance is less than 5 ohms, repair short to ground in Orange/Dark Blue wire. Perform TEST VER-1. If resistance is more than 5 ohms, replace TCM. Perform TEST VER-1.

## TEST FC-18A - IDLE AIR CONTROL MOTOR CIRCUITS

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Turn ignition off. Start engine. Allow engine to reach normal operating temperature. Using DRB-II, read fault messages. If DRB-II displays IDLE AIR CONTROL MOTOR CIRCUITS, go to step 4).

2) If DRB-II does not display IDLE AIR CONTROL MOTOR CIRCUITS, condition required to set fault is not present at this time. IDLE AIR CONTROL MOTOR CIRCUITS fault sets if any of 4 Idle Air Control (IAC) motor wires are shorted to ground or battery voltage. Possible causes are: IAC motor internally shorted or IAC motor wires shorted together. Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Turn ignition off. Disconnect Idle Air Control (IAC) motor connector. Turn ignition on. Using DRB-II, actuate IAC motor. Using DRB-II in voltmeter mode, check voltage on each IAC motor connector wire at IAC motor connector. Normal voltage reading will switch from less than one volt to more than 10 volts.

5) If voltage is less than one volt on any IAC motor wire, repair appropriate wire for short to ground. Perform TEST VER-1. If voltage is more than 10 volts on any IAC motor wire, repair appropriate wire for short to voltage. Perform TEST VER-1.

6) Turn ignition off. Reconnect IAC motor connector. Disconnect PCM. Using an external ohmmeter, check resistance between terminals No. 39 and 59 at PCM connector. If resistance is more than 35 ohms, go to next step. If resistance is less than 35 ohms, replace IAC motor. Perform TEST VER-1.

7) Using an external ohmmeter, check resistance between terminals No. 40 and 60 at PCM connector. If resistance is less than 35 ohms, replace IAC motor. Perform TEST VER-1. If resistance is more than 35 ohms, check resistance between terminals No. 39 and 60 at PCM



connector using DRB-II.

8) If resistance is more than 10 ohms, but less than 75 ohms, go to step 10). If resistance is less than 10 ohms, repair IAC driver circuits No. 1 and 2 for shorting together. See appropriate PCM TERMINAL IDENTIFICATION table for wire color identification. Perform TEST VER-1.

9) If resistance is 75-120 ohms, repair IAC driver circuits No. 3 and 4 for shorting together. See appropriate PCM TERMINAL IDENTIFICATION table for wire color identification. Perform TEST VER-1. If resistance is more than 120 ohms, replace PCM. Perform TEST VER-1.

10) If resistance is less than 75 ohms, check resistance between terminals No. 59 and 60 at PCM connector. If resistance is less than 10 ohms, repair IAC driver circuits No. 2 and 4 for shorting together. See appropriate PCM TERMINAL IDENTIFICATION table for wire color identification. Perform TEST VER-1.

11) If resistance is more than 10 ohms, repair IAC driver circuits No. 1 and 4 for shorting together. See appropriate PCM TERMINAL IDENTIFICATION table for wire color identification. Perform TEST VER-1.

PCM TERMINAL IDENTIFICATION TABLE (1) (XJ & YJ BODIES)

Wire Color & (PCM Terminal No.)	IAC Driver No.	Connector Terminal No.
Gray/Red (39) .....	3 .....	1
Brown/White (40) .....	1 .....	3
Violet/Black (59) .....	4 .....	4
Yellow/Black (60) .....	2 .....	2

(1) - For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article.

PCM TERMINAL IDENTIFICATION TABLE (1) (ZJ BODY)

Wire Color & (PCM Terminal No.)	IAC Driver No.	Connector Terminal No.
Yellow/Black (39) .....	3 .....	1
Brown/White (40) .....	1 .....	3
Gray/Red (59) .....	4 .....	4
Violet/Black (60) .....	2 .....	2

(1) - For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article.

## TEST FC-19A - INJECTOR #1 CONTROL CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If engine started, allow engine to idle for at least 20 seconds. If DRB-II does not display INJECTOR #1 CONTROL CIRCUIT, condition required to set fault is not present at this time. Go to next step. If DRB-II displays

INJECTOR #1 CONTROL CIRCUIT, go to step 6).

3) INJECTOR #1 CONTROL CIRCUIT fault sets if Powertrain Control Module (PCM) does not detect injector "turn off edge" when expected. Possible causes are: open or shorted injector ground circuit (White/Dark Blue wire), open injector power supply circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body), open injector, or failed driver in Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

5) Start engine. Wiggle wiring harness from injector No. 1 to Powertrain Control Module (PCM). If engine misfires or stalls, repair wiring harness as necessary. Perform TEST VER-1. If engine does not misfire or stall, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

6) Turn ignition off. Disconnect injector No. 1 connector. Using an external ohmmeter, check resistance of injector No. 1. If resistance is not 10-16 ohms, replace injector. Perform TEST VER-1. If resistance is 10-16 ohms, turn ignition on. Using DRB-II, actuate injector No. 1.

7) Using DRB-II in voltmeter mode, check voltage on injector connector (harness side) Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. If voltage is less than 10 volts, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1.

8) If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of injector driver circuit (White/Dark Blue wire), between PCM connector terminal No. 16 and injector connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in White/Dark Blue wire. Perform TEST VER-1.

9) Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 16, injector driver circuit (White/Dark Blue wire). If resistance is less than 5 ohms, repair short to ground in White/Dark Blue wire. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-20A - INJECTOR #2 CONTROL CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If engine started, allow engine to idle for at least 20 seconds. If DRB-II does not display INJECTOR #2 CONTROL CIRCUIT, condition required to set fault is not present at this time. Go to next step. If DRB-II displays INJECTOR #2 CONTROL CIRCUIT, go to step 6).

3) INJECTOR #2 CONTROL CIRCUIT fault sets if Powertrain Control Module (PCM) does not detect injector "turn off edge" when expected. Possible causes are: open or shorted injector ground circuit (Tan wire), open injector power supply circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body), open injector, or failed driver in Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

5) Start engine. Wiggle wiring harness from injector No. 2 to Powertrain Control Module (PCM). If engine misfires or stalls, repair wiring harness as necessary. Perform TEST VER-1. If engine does not misfire or stall, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

6) Turn ignition off. Disconnect injector No. 2 connector. Using an external ohmmeter, check resistance of injector No. 2. If resistance is not 10-16 ohms, replace injector. Perform TEST VER-1. If resistance is 10-16 ohms, turn ignition on. Using DRB-II, actuate injector No. 2.

7) Using DRB-II in voltmeter mode, check voltage on injector connector (harness side) Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. If voltage is less than 10 volts, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1.

8) If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of injector driver circuit (Tan wire) between PCM connector terminal No. 15 and injector connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Tan wire. Perform TEST VER-1.

9) Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 15, injector driver circuit (Tan wire). If resistance is less than 5 ohms, repair short to ground in Tan wire. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-21A - INJECTOR #3 CONTROL CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If engine started, allow engine to idle for at least 20 seconds. If DRB-II does not display INJECTOR #3 CONTROL CIRCUIT, condition required to set fault is not present at this time. Go to next step. If DRB-II displays INJECTOR #3 CONTROL CIRCUIT, go to step 6).

3) INJECTOR #3 CONTROL CIRCUIT fault sets if Powertrain Control Module (PCM) does not detect injector "turn off edge" when expected. Possible causes are: open or shorted injector ground circuit (Yellow/White wire), open injector power supply circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body), open injector, or failed driver in Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

5) Start engine. Wiggle wiring harness from injector No. 3 to Powertrain Control Module (PCM). If engine misfires or stalls, repair wiring harness as necessary. Perform TEST VER-1. If engine does not misfire or stall, see INACTIVE FAULT CONDITION in SELF-DIAGNOSTICS. Perform TEST VER-1.

6) Turn ignition off. Disconnect injector No. 3 connector. Using an external ohmmeter, check resistance of injector No. 3. If resistance is not 10-16 ohms, replace injector. Perform TEST VER-1. If resistance is 10-16 ohms, turn ignition on. Using DRB-II, actuate injector No. 3.

7) Using DRB-II in voltmeter mode, check voltage on injector connector (harness side) Dark Green/Orange wire on XJ and YJ bodies or

Dark Green/Black wire on ZJ body. If voltage is less than 10 volts, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1.

8) If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of injector driver circuit (Yellow/White wire) between PCM connector terminal No. 14 and injector connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Yellow/White wire. Perform TEST VER-1.

9) Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 14, injector driver circuit (Yellow/White wire). If resistance is less than 5 ohms, repair short to ground in Yellow/White wire. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-22A - INJECTOR #4 CONTROL CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If engine started, allow engine to idle for at least 20 seconds. If DRB-II does not display INJECTOR #4 CONTROL CIRCUIT, condition required to set fault is not present at this time. Go to next step. If DRB-II displays INJECTOR #4 CONTROL CIRCUIT, go to step 6).

3) INJECTOR #4 CONTROL CIRCUIT fault sets if Powertrain Control Module (PCM) does not detect injector "turn off edge" when expected. Possible causes are: open or shorted injector ground circuit (Light Blue/Brown wire), open injector power supply circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body), open injector, or failed driver in Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

5) Start engine. Wiggle wiring harness from injector No. 4 to Powertrain Control Module (PCM). If engine misfires or stalls, repair wiring harness as necessary. Perform TEST VER-1. If engine does not misfire or stall, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

6) Turn ignition off. Disconnect injector No. 4 connector. Using an external ohmmeter, check resistance of injector No. 4. If resistance is not 10-16 ohms, replace injector. Perform TEST VER-1. If resistance is 10-16 ohms, turn ignition on. Using DRB-II, actuate injector No. 4.

7) Using DRB-II in voltmeter mode, check voltage on injector connector (harness side) Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. If voltage is less than 10 volts, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1.

8) If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of injector driver circuit (Light Blue/Brown wire), between PCM connector terminal No. 13 and injector connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Light Blue/Brown wire. Perform TEST VER-1.

9) Using DRB-II in ohmmeter mode, check resistance of PCM

connector terminal No. 13, injector driver circuit (Light Blue/Brown wire). If resistance is less than 5 ohms, repair short to ground in Light Blue/Brown wire. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-23A - INJECTOR #5 CONTROL CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If engine started, allow engine to idle for at least 20 seconds. If DRB-II does not display INJECTOR #5 CONTROL CIRCUIT, condition required to set fault is not present at this time. Go to next step. If DRB-II displays INJECTOR #5 CONTROL CIRCUIT, go to step 6).

3) INJECTOR #5 CONTROL CIRCUIT fault sets if Powertrain Control Module (PCM) does not detect injector "turn off edge" when expected. Possible causes are: open or shorted injector ground circuit (Pink/Black wire on XJ and YJ bodies or Gray wire on ZJ body), open injector power supply circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body), open injector, or failed driver in Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

5) Start engine. Wiggle wiring harness from injector No. 5 to Powertrain Control Module (PCM). If engine misfires or stalls, repair wiring harness as necessary. Perform TEST VER-1. If engine does not misfire or stall, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

6) Turn ignition off. Disconnect injector No. 5 connector. Using an external ohmmeter, check resistance of injector No. 5. If resistance is not 10-16 ohms, replace injector. Perform TEST VER-1. If resistance is 10-16 ohms, turn ignition on. Using DRB-II, actuate injector No. 5.

7) Using DRB-II in voltmeter mode, check voltage on injector connector (harness side) Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. If voltage is less than 10 volts, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1.

8) If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of injector driver circuit (Pink/Black wire on XJ and YJ bodies or Gray wire on ZJ body) between PCM connector terminal No. 38 and injector connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Pink/Black wire on XJ and YJ bodies or Gray wire on ZJ body. Perform TEST VER-1.

9) Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 38, injector driver circuit (Pink/Black wire on XJ and YJ bodies or Gray wire on ZJ body). If resistance is less than 5 ohms, repair short to ground in Pink/Black wire on XJ and YJ bodies or Gray wire on ZJ body. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-24A - INJECTOR #6 CONTROL CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams,

see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Attempt to start engine. If engine will not start, crank engine for at least 10 seconds.

2) Using DRB-II, read fault messages. If engine started, allow engine to idle for at least 20 seconds. If DRB-II does not display INJECTOR #6 CONTROL CIRCUIT, condition required to set fault is not present at this time. Go to next step. If DRB-II displays INJECTOR #6 CONTROL CIRCUIT, go to step 6).

3) INJECTOR #6 CONTROL CIRCUIT fault sets if Powertrain Control Module (PCM) does not detect injector "turn off edge" when expected. Possible causes are: open or shorted injector ground circuit (Light Green/Black wire on XJ and YJ bodies or Brown/Yellow wire on ZJ body), open injector power supply circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body), open injector, or failed driver in Powertrain Control Module (PCM). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

5) Start engine. Wiggle wiring harness from injector No. 6 to Powertrain Control Module (PCM). If engine misfires or stalls, repair wiring harness as necessary. Perform TEST VER-1. If engine does not misfire or stall, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

6) Turn ignition off. Disconnect injector No. 6 connector. Using an external ohmmeter, check resistance of injector No. 6. If resistance is not 10-16 ohms, replace injector. Perform TEST VER-1. If resistance is 10-16 ohms, turn ignition on. Using DRB-II, actuate injector No. 6.

7) Using DRB-II in voltmeter mode, check voltage on injector connector (harness side) Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. If voltage is less than 10 volts, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1.

8) If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of injector driver circuit (Light Green/Black wire on XJ and YJ bodies or Brown/Yellow wire on ZJ body), between PCM connector terminal No. 58 and injector connector. If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, repair open in Light Green/Black wire on XJ and YJ bodies or Brown/Yellow wire on ZJ body. Perform TEST VER-1.

9) Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 58, injector driver circuit (Light Green/Black wire on XJ and YJ bodies or Brown/Yellow wire on ZJ body). If resistance is less than 5 ohms, repair short to ground in Light Green/Black wire on XJ and YJ bodies or Brown/Yellow wire on ZJ body. Perform TEST VER-1. If resistance is more than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-25A - A/C CLUTCH RELAY CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Turn ignition on. On XJ and YJ bodies, actuate A/C clutch relay using DRB-II. On ZJ body, actuate A/C clutch relay and Auto Shutdown (ASD) relay using DRB-II. On all bodies, if A/C clutch relay is clicking, go to next step. If A/C clutch relay is not clicking, go to step 5).

2) Condition required to set fault is not present at this time. A/C CLUTCH RELAY CIRCUIT fault sets if A/C clutch relay control circuit (Dark Blue/Orange wire on XJ and YJ bodies or Dark Blue/Red wire on ZJ body) is not in its proper state when monitored by Powertrain Control Module (PCM). Possible causes are: open or short in A/C clutch relay coil windings, open or short in A/C clutch relay control circuit (Dark Blue/Orange wire on XJ and YJ bodies or Dark Blue/Red wire on ZJ body), open or short in A/C clutch relay ignition feed circuit (Dark Blue/White wire on XJ and YJ bodies or Yellow/Dark Green wire on ZJ body), or failed driver in Powertrain Control Module (PCM). Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

4) While still actuating A/C clutch and ASD relay, wiggle wiring harness from A/C clutch relay to Powertrain Control Module (PCM). Stop actuation of relays. Using DRB-II, read fault messages. If A/C CLUTCH RELAY CIRCUIT fault returns, repair wiring harness as necessary. Perform TEST VER-1. If A/C CLUTCH RELAY CIRCUIT fault does not return, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

5) Remove A/C clutch relay. Install a known good A/C clutch relay. If known good A/C clutch relay is clicking, replace original A/C clutch relay. Perform TEST VER-1. If known good A/C clutch relay is not clicking, remove known good A/C clutch relay.

6) Ensure A/C clutch relay actuation test is still running. Using DRB-II in voltmeter mode, check voltage on A/C clutch relay connector, ignition feed circuit (Dark Blue/White wire on XJ and YJ bodies or Yellow/Dark Green wire on ZJ body). If voltage is less than 10 volts, repair open in Dark Blue/White wire on XJ and YJ bodies or Yellow/Dark Green wire on ZJ body. Perform TEST VER-1.

7) If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance of A/C clutch relay connector, control circuit (Dark Blue/Orange wire on XJ and YJ bodies or Dark Blue/Red wire on ZJ body). If resistance is less than 5 ohms, repair short to ground in Dark Blue/Orange wire on XJ and YJ bodies or Dark Blue/Red wire on ZJ body. Perform TEST VER-1.

8) If resistance is more than 5 ohms, check resistance of control circuit (Dark Blue/Orange wire on XJ and YJ bodies or Dark Blue/Red wire on ZJ body) between A/C clutch relay connector and PCM connector terminal No. 34 using an external ohmmeter. If resistance is more than 5 ohms, repair open in Dark Blue/Orange wire on XJ and YJ bodies or Dark Blue/Red wire on ZJ body. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-26A - RAD FAN CONTROL RELAY CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Turn ignition on. Using DRB-II, actuate radiator fan relay. If radiator fan relay is clicking, condition required to set fault is not present at this time. Go to next step. If radiator fan relay is not clicking, go to step 5).

2) RAD FAN CONTROL RELAY CIRCUIT fault sets if radiator fan relay control circuit (Dark Blue/Pink wire) is not in its proper state when monitored by Powertrain Control Module (PCM). Possible causes are: open or short in radiator fan relay coil windings, open or short in radiator fan relay control circuit (Dark Blue/Pink wire), open or short in radiator fan relay ignition feed circuit (Dark Blue/White wire), or failed driver in Powertrain Control Module (PCM). Go to next

step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

4) While still actuating radiator fan relay, wiggle wiring harness from radiator fan relay to Powertrain Control Module (PCM). Stop actuation of radiator fan relay. Using DRB-II, read fault messages. If RAD FAN CONTROL RELAY CIRCUIT fault returns, repair wiring harness as necessary. Perform TEST VER-1. If RAD FAN CONTROL RELAY CIRCUIT fault does not return, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

5) Remove radiator fan relay. Install a known good radiator fan relay. If known good radiator fan relay is clicking, replace original radiator fan relay. Perform TEST VER-1. If known good radiator fan relay is not clicking, remove known good radiator fan relay.

6) DRB-II should still be actuating radiator fan relay. Using DRB-II in voltmeter mode, check voltage on radiator fan relay connector, ignition feed circuit (Dark Blue/White wire). If voltage is less than 10 volts, repair open in Dark Blue/White wire. Perform TEST VER-1. If voltage is more than 10 volts, turn ignition off.

7) Disconnect PCM connector. Using DRB-II in ohmmeter mode, check resistance of radiator fan relay connector, control circuit (Dark Blue/Pink wire). If resistance is less than 5 ohms, repair short to ground in Dark Blue/Pink wire. Perform TEST VER-1.

8) If resistance is more than 5 ohms, check resistance of control circuit (Dark Blue/Pink wire) between radiator fan relay connector and PCM connector terminal No. 31 using an external ohmmeter. If resistance is more than 5 ohms, repair open in Dark Blue/Pink wire. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-27A - AUTO SHUTDOWN RELAY CONTROL CIRCUIT

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages and actuate Auto Shutdown (ASD) relay. If ASD relay is clicking, condition required to set fault is not present at this time. Go to next step. If ASD relay is not clicking, go to step 5).

2) AUTO SHUTDOWN RELAY CONTROL CIRCUIT fault sets if Auto Shutdown (ASD) relay and fuel pump relay control circuit (Dark Blue/Yellow wire on XJ and YJ bodies or Pink wire on ZJ body) are not in proper state when monitored by Powertrain Control Module (PCM) during cranking. Possible causes are: open or short in ASD relay and fuel pump relay control circuits (Dark Blue/Yellow wire on XJ and YJ bodies or Pink wire on ZJ body), open or short in ASD relay ignition feed circuit (Dark Blue wire on XJ body, White/Yellow wire on YJ body or Light Blue/Red wire on ZJ body), or failed driver in Powertrain Control Module (PCM). Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, go to next step.

4) While still actuating ASD relay, wiggle wiring harness from ASD relay to Powertrain Control Module (PCM). Stop actuation of ASD relay. Using DRB-II, read fault messages. If AUTO SHUTDOWN RELAY CONTROL CIRCUIT fault returns, repair wiring harness as necessary. Perform TEST VER-1. If AUTO SHUTDOWN RELAY CONTROL CIRCUIT fault does not return, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

5) Remove ASD relay. Install a known good ASD relay. If known



good ASD relay is clicking, replace original ASD relay. Perform TEST VER-1. If known good ASD relay is not clicking, remove known good ASD relay.

6) DRB-II should still be actuating ASD relay. Using DRB-II in voltmeter mode, check voltage on ASD relay connector, ignition feed circuit (Dark Blue wire on XJ body, White/Yellow wire on YJ body or Light Blue/Red wire on ZJ body). If voltage is less than 10 volts, repair open in Dark Blue wire on XJ body, White/Yellow wire on YJ body or Light Blue/Red wire on ZJ body. Perform TEST VER-1. If voltage is more than 10 volts, turn ignition off.

7) Disconnect PCM connector. Using DRB-II in ohmmeter mode, check resistance of ASD relay connector, control circuit (Dark Blue/Yellow wire on XJ and YJ bodies or Pink wire on ZJ body). If resistance is less than 5 ohms, repair short to ground in Dark Blue/Yellow wire on XJ and YJ bodies or Pink wire on ZJ body. Perform TEST VER-1.

8) If resistance is more than 5 ohms, check resistance of control circuit (Dark Blue/Yellow wire on XJ and YJ bodies or Pink wire on ZJ body) between ASD relay connector and PCM connector terminal No. 51 using an external ohmmeter. If resistance is more than 5 ohms, repair open in Dark Blue/Yellow wire on XJ and YJ bodies or Pink wire on ZJ body. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST FC-28A - NO ASD RELAY VOLT SENSE AT PCM

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Attempt to start engine. If engine does not start, go to step 5). If engine starts, run engine for 5 minutes.

2) Using DRB-II, read fault messages. If DRB-II displays NO ASD RELAY VOLT SENSE AT PCM, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body, between Auto Shutdown (ASD) relay connector and Powertrain Control Module (PCM) connector terminal No. 57. Perform TEST VER-1.

3) If DRB-II does not display NO ASD RELAY VOLT SENSE AT PCM, condition required to set fault is not present at this time. NO ASD RELAY VOLT SENSE AT PCM fault sets if ASD output voltage is not sensed when ASD relay is energized. Possible causes are: open ASD relay output wire (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body), open ASD relay control circuit wire (Dark Blue/Yellow on XJ and YJ bodies or Pink on ZJ body), failed ASD and fuel pump relays or open battery feed circuit to ASD relay (Red/Black wire on XJ body, Red/White wire on YJ body or Red wire on ZJ body). Go to next step.

4) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1. Go to next step.

5) If engine does not start, disconnect ASD relay. Using DRB-II in voltmeter mode, check voltage on ASD relay connector, battery feed circuit (Red/Black wire on XJ body, Red/White wire on YJ body or Red wire on ZJ body). If voltage is less than 12 volts, repair open in Red/Black wire on XJ body, Red/White wire on YJ body or Red wire on ZJ body. Perform TEST VER-1.

6) If voltage is more than 12 volts, turn ignition off. Disconnect PCM connector. Using DRB-II in ohmmeter mode, check resistance of output circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body) between ASD relay connector and PCM connector terminal No. 57.

7) If resistance is more than 5 ohms, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1. If resistance is less than 5 ohms, reconnect PCM connector. Install a known good ASD relay. Attempt to start engine. If engine starts, replace original ASD relay. Perform TEST VER-1. If engine does not start, replace PCM. Perform TEST VER-1.

## **TEST FC-29A OR FC-30A - PCM FAILURE SRI MILE NOT STORED**

OR PCM FAILURE EEPROM WRITE DENIED

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition on. Using DRB-II, perform SRI memory test. If DRB-II displays WRITE FAILURE, replace Powertrain Control Module (PCM). Perform TEST VER-1. If DRB-II does not display WRITE FAILURE, go to next step.

2) If DRB-II displays WRITE REFUSED, go to step 3). If DRB-II does not display WRITE REFUSED, go to next step. If DRB-II displays SRI MILEAGE INVALID, update mileage and retest SRI memory. Perform TEST VER-1. If DRB-II does not display SRI MILEAGE INVALID, compare SRI mileage stored with instrument panel odometer. If mileage is same, retest SRI memory. Perform TEST VER-1. If mileage is not same, update mileage and retest SRI memory. Perform TEST VER-1.

3) When DRB-II displays WRITE REFUSED, Powertrain Control Module (PCM) was busy. Using DRB-II, perform SRI memory test. Retest SRI memory 2 more times if necessary. If DRB-II displays WRITE REFUSED, replace PCM. Perform TEST VER-1. If DRB-II does not display WRITE REFUSED, vehicle is functioning properly. Perform TEST VER-1.

## **TEST FC-31A - FUEL PUMP RESISTOR BY-PASS RELAY CIRCUIT**

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, erase fault messages. Start engine. Using DRB-II, read fault messages. If DRB-II displays FUEL PUMP RESISTOR BY-PASS RELAY CIRCUIT, go to step 4). If DRB-II does not display FUEL PUMP RESISTOR BY-PASS RELAY CIRCUIT, condition required to set fault is not present at this time. Go to next step.

2) FUEL PUMP RESISTOR BY-PASS RELAY CIRCUIT fault sets if by-pass relay control circuit (Red/Dark Blue wire) is not in its proper state when monitored by Powertrain Control Module (PCM). Possible causes are: open or shorted relay coil windings, open or shorted relay control circuit (Red/Dark Blue wire), open ignition feed circuit (Dark Blue/White wire) or failed Powertrain Control Module (PCM). Go to next step.

3) Inspect all related wiring and connectors and repair as necessary. Perform TEST VER-1. If no problems were found with wiring and connectors, see INACTIVE FAULT CONDITION. Perform TEST VER-1.

4) Turn ignition off. Disconnect fuel pump resistor by-pass relay connector (located forward of power distribution center, underhood). Inspect connector for damaged or pushed-out terminals. Repair as necessary. Perform TEST VER-1. If connector is okay, go to next step.

5) Using an external ohmmeter, check resistance of by-pass relay (Dark Blue/White wire and Red/Dark Blue wire terminals). If resistance is more than 80 ohms, replace by-pass relay. Perform TEST VER-1. If resistance is less than 80 ohms, turn ignition on.

6) Using DRB-II in voltmeter mode, check voltage of ignition feed circuit (Dark Blue/White wire). If voltage is less than 10 volts, repair open in Dark Blue/White wire. Perform TEST VER-1. If voltage is more than 10 volts, turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Go to next step.

7) Using DRB-II in ohmmeter mode, check resistance at PCM connector terminal No. 37. If resistance is less than 5 ohms, repair short to ground in Red/Dark Blue wire. Perform TEST VER-1. If resistance is more than 5 ohms, check resistance between by-pass relay connector and PCM connector terminal No. 37 (Red/Dark Blue wire) using an external ohmmeter. If resistance is more than 5 ohms, repair open in Red/Dark Blue wire. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST NF-1A - NO FAULT CODE TEST MENU

### No Fault Complete Test

Check MITCHELL(R) TECH SERVICE BULLETINS (TSBs) for any pertinent information. If a TSB exists, perform corrective action. If TSB does not exist or if driveability problem still exists, perform tests NF-2A through NF-12A in sequence until driveability problem is found. See NO FAULT CODE TEST MENU table.

NO FAULT CODE TEST MENU TABLE

Application	Test
Checking Secondary Ignition & Timing .....	NF-2A
Checking Fuel Pressure .....	NF-3A
Checking Coolant Sensor Calibration .....	NF-4A
Checking TPS Calibration .....	NF-5A
Checking MAP Sensor Calibration .....	NF-6A
Checking Oxygen (O2) Sensor Switching .....	NF-7A
Checking Idle Air Control Motor .....	NF-8A
Checking Park/Neutral Switch .....	NF-9A
Checking PCM Grounds & Power Circuits .....	NF-10A
Checking Engine Vacuum .....	NF-11A
No Fault Code Mechanical Test .....	NF-12A

### No Fault Quick Individual Test

If it is suspected that any item listed in NO FAULT CODE TEST MENU table is cause of a vehicle's driveability problem, perform associated test(s) individually. Return to NO FAULT CODE TEST MENU table if driveability problem still exists, or perform NO FAULT COMPLETE TEST.

### No Fault Quick Symptom Test

Symptom checks cannot be used properly unless driveability problem characteristic actually happens while vehicle is being tested. To reduce diagnostic time, ensure that TEST FC-1A is reviewed before attempting to diagnose a symptom.

Select symptom that most accurately describes vehicle's driveability problem and then perform test pertaining to this symptom. Perform each test in sequence until problem is found. See NO FAULT QUICK SYMPTOM TEST MENU table.

NO FAULT QUICK SYMPTOM TEST MENU TABLE

Application	Test
Hard Start .....	NF-2A, 3A-8A, 10A, 11A, 12A
Start & Stall .....	NF-2A, 3A-6A, 8A, 10A, 12A

Hesitation/Sag/Stumble .....	(1)
Surge .....	NF-2A, 3A-8A, 10A, 12A
Lack Of Power/Sluggish .....	NF-2A, 3A-8A, 10A, 11A, 12A
Spark Knock/Detonation .....	NF-2A, 3A-7A, 11A, 12A
Cuts Out/Misses .....	NF-2A, 3A, 7A, 10A, 11A, 12A
Backfire/Popback .....	NF-2A, 3A, 6A, 7A, 10A, 11A, 12A
Runs Rough/Unstable/Erratic Idle .....	(1)
Poor Fuel Economy .....	(1)

(1) - Perform tests NF-2A through NF-12A in sequence. See NO FAULT CODE TEST MENU table.

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## TEST NF-2A - CHECKING SECONDARY IGNITION & TIMING

1) Turn engine off. Connect engine analyzer to engine. Start engine and let idle. If engine will not idle, maintain engine speed for reading scope pattern. Set scope to read display or parade pattern. Follow equipment manufacturer's procedure for pattern analysis.

2) If secondary ignition pattern is not okay, repair indicated component in secondary ignition system. Perform TEST VER-1. If secondary ignition pattern is okay, disconnect any spark plug wire. Observe secondary kilovolt line.

3) If open circuit secondary voltage is not at least 25 kilovolts, replace electronic ignition coil. Perform TEST VER-1. If open circuit secondary voltage is at least 25 kilovolts, reinstall spark plug wire.

4) Ensure engine temperature is more than 180°F (82°C) before proceeding. Using DRB-II, read total spark advance. Increase engine speed to 2000 RPM. If spark advance does not change with increase in RPM, replace Powertrain Control Module (PCM). Perform TEST VER-1. If spark advance changes with increase in RPM, ignition timing is functioning properly. Test is complete.

## TEST NF-3A - CHECKING FUEL PRESSURE

**WARNING:** High fuel pressure may be present in fuel lines. Open fuel system with caution. See FUEL PRESSURE RELEASE procedure.

1) Release fuel pressure. Connect fuel pressure gauge to fuel rail. Turn ignition on. Using DRB-II, actuate fuel system. If fuel pressure is 34-43 psi (2.3-3.0 kg/cm<sup>2</sup>), fuel pressure is normal. Test is complete. If fuel pressure is not 34-43 psi (2.3-3.0 kg/cm<sup>2</sup>), record fuel pressure reading. If fuel pressure is more than 43 psi (3.0 kg/cm<sup>2</sup>), go to TEST NF-3B.

2) If fuel pressure is less than 43 psi (3.0 kg/cm<sup>2</sup>), stop fuel system actuation. Turn ignition off. Inspect fuel lines for kinked or restricted lines. Repair fuel lines as necessary. Perform TEST VER-1.

3) If no kinked or restricted lines exist, release fuel pressure. Remove fuel pressure gauge. Install fuel pressure gauge between fuel tank and fuel filter. Turn ignition on. Using DRB-II, actuate fuel system. If fuel pressure is at least 5 psi (.4 kg/cm<sup>2</sup>) more than previously recorded pressure, replace fuel filter. Perform TEST VER-1.

**CAUTION:** DO NOT allow fuel pressure to exceed 60 psi (4.2 kg/cm<sup>2</sup>) when squeezing fuel return hose.

4) If fuel pressure is not at least 5 psi (.4 kg/cm<sup>2</sup>) more than previous reading, gently squeeze fuel return hose while observing fuel pressure gauge, ensuring fuel pressure does not exceed 60 psi (4.2 kg/cm<sup>2</sup>).

2 kg/cm<sup>2</sup>). If fuel pressure increases, replace fuel pressure regulator. Perform TEST VER-1. If fuel pressure does not increase, replace fuel pump and sock assembly. Perform TEST VER-1.

## TEST NF-3B - CHECKING FUEL PRESSURE

**WARNING:** High fuel pressure may be present in fuel lines. Open fuel system with caution. See FUEL PRESSURE RELEASE procedure.

1) Using DRB-II, stop fuel system actuation. Release fuel pressure. Ensure fuel tank is at least 1/4 full before performing following test. Install fuel pressure gauge and adapter between fuel tank and filter at rear of vehicle.

2) Remove fuel return line from fuel pump at fuel tank. Connect Fuel Pressure Test Adapter (6541) to fuel return line. Place other end of adapter hose into an approved 2-gallon gasoline can. Turn ignition on.

3) Using DRB-II, actuate fuel system. Observe fuel pressure gauge. If fuel pressure is 34-43 psi (2.3-3.0 kg/cm<sup>2</sup>), repair fuel return line for a restriction at fuel tank. Perform TEST VER-1.

4) If fuel pressure is not 34-43 psi (2.3-3.0 kg/cm<sup>2</sup>), stop fuel system actuation. Release fuel pressure. Reconnect fuel return line to fuel tank. Disconnect fuel return line from fuel rail.

5) Attach Fuel Pressure Test Adapter (6541) to fuel return line nipple at fuel rail. Place other end of adapter hose into an approved 2-gallon gasoline can. Turn ignition on. Using DRB-II, actuate fuel system. Observe fuel pressure gauge.

6) If fuel pressure is 34-43 psi (2.3-3.0 kg/cm<sup>2</sup>), repair fuel return line for a restriction to fuel tank. Perform TEST VER-1. If fuel pressure is not 34-43 psi (2.3-3.0 kg/cm<sup>2</sup>), replace fuel pressure regulator. Perform TEST VER-1.

## TEST NF-4A - CHECKING COOLANT SENSOR CALIBRATION

1) Start engine. Using DRB-II, read Engine Coolant Temperature (ECT) sensor value. If ECT sensor temperature is more than 180°F (82°C), stop engine. Allow engine coolant to cool to 150°F (66°C). Start engine. Allow engine to reach normal operating temperature of 180°F (82°C). If ECT sensor value does not increase smoothly, inspect cooling system for mechanical failure. If cooling system is okay, replace ECT sensor. Perform TEST VER-1. If ECT sensor value increases smoothly, go to next step.

2) If ECT sensor value does not reach 180°F (82°C) or more, inspect cooling system for mechanical failure. If system is okay, replace ECT sensor. Perform TEST VER-1. If ECT sensor value reaches 180°F (82°C) or more, ECT sensor is functioning properly. Test is complete.

## TEST NF-5A - CHECKING TPS CALIBRATION

1) Turn engine off. Turn ignition on. Using DRB-II, read Throttle Position Sensor (TPS) voltage. Ensure throttle is fully closed and against throttle stop.

2) If voltage is not one volt or less with throttle closed, replace TPS. Perform TEST VER-1. If voltage is one volt or less with throttle closed, watch voltage while slowly opening throttle wide open. If voltage change is not smooth, replace TPS. Perform TEST VER-1. If voltage change is smooth, go to next step.

3) If maximum voltage is not at least 3.6 volts at wide open throttle, replace TPS. Perform TEST VER-1. If maximum voltage is at least 3.6 volts at wide open throttle, using DRB-II in voltmeter mode, check minimum throttle voltage. If voltage is not 0 to 1 volt, replace TPS. Perform TEST VER-1. If voltage is 0 to 1 volt, TPS is functioning

properly. Test is complete.

## TEST NF-6A - CHECKING MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CALIBRATION

1) Turn engine off. Install vacuum "T" in MAP sensor vacuum hose. Install vacuum gauge. Start engine and let idle. If engine will not idle, maintain a constant RPM above idle. Using DRB-II, read MAP value. If reading is within one in. Hg of vacuum gauge reading, MAP sensor is functioning properly. Test is complete. If reading is not within one in. Hg of vacuum gauge reading, turn engine off.

2) Disconnect vacuum gauge. Connect vacuum pump to MAP sensor. Apply 5 in. Hg of vacuum to MAP sensor. Turn ignition on. Using DRB-II, read and record MAP sensor voltage. Increase vacuum to 20 in. Hg. Using DRB-II, read and record MAP sensor voltage. Subtract 20 in. Hg voltage reading from 5 in. Hg voltage reading. If difference in voltage is 2.3-2.9 volts, repair restriction in MAP sensor vacuum hose. Perform TEST VER-1. If difference in voltage is not 2.3-2.9 volts, replace MAP sensor. Perform TEST VER-1.

## TEST NF-7A - CHECKING OXYGEN (O2) SENSOR SWITCHING

**WARNING:** High fuel pressure may be present in fuel lines. Open fuel system with caution. See FUEL PRESSURE RELEASE procedure.

1) Allow engine to reach normal operating temperature. Using DRB-II, read O2 sensor state. If O2 sensor state is switching, system is functioning properly. Test is complete. If O2 sensor state is not switching, check if O2 sensor is locked on lean. If O2 sensor is locked on lean, go to TEST NF-7B. If O2 sensor is not locked on lean, turn engine off.

2) Connect fuel pressure gauge to fuel rail. Turn ignition on. Using DRB-II, actuate fuel system. Allow fuel pressure gauge to stabilize to normal fuel pressure of 34-43 psi (2.3-3.0 kg/cm<sup>2</sup>). Stop fuel system actuation. Monitor fuel pressure gauge for one minute. Go to next step.

3) If gauge pressure decreased more than 10 psi (.8 kg/cm<sup>2</sup>), replace leaking fuel injectors or "O" rings as necessary. Perform TEST VER-1. If gauge pressure decreased less than 10 psi (.8 kg/cm<sup>2</sup>), inspect air cleaner and inlet ducts for restrictions. Repair as necessary. Perform TEST VER-1. If no restrictions are observed, go to TEST NF-12A.

## TEST NF-7B - CHECKING OXYGEN (O2) SENSOR SWITCHING

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Allow engine to idle. Inspect engine for vacuum leaks. Repair vacuum leaks as necessary. Perform TEST VER-1. If no vacuum leaks exist, read O2 sensor signal voltage using DRB-II.

2) If voltage is more than 0.1 volt, go to step 4). If voltage is less than 0.1 volt, turn ignition off. Disconnect O2 sensor connector. Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance of O2 sensor connector (harness side), signal circuit (Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body).

3) If resistance is less than 10 ohms, repair short to ground in Black/Dark Green wire on XJ and YJ bodies or Black/Orange wire on ZJ body. Perform TEST VER-1. If resistance is more than 10 ohms, replace O2 sensor. Perform TEST VER-1.

4) Turn engine off. Replace O2 sensor. Turn ignition on. Using DRB-II, reset adaptive fuel memory. Start engine. Allow engine to reach normal operating temperature.

5) Using DRB-II, read O2 sensor state. If O2 sensor state is switching, repair is complete. Perform TEST VER-1. If O2 sensor state is not switching, go to TEST NF-12A.

## TEST NF-8A - CHECKING IDLE AIR CONTROL MOTOR

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, set engine speed to 1100 RPM. If engine speed set at 1050-1150 RPM, idle speed motor is operating properly. Test is complete. If engine speed did not set at 1050-1150 RPM, return engine to normal idle speed. Disconnect idle air control motor connector.

2) Using DRB-II in voltmeter mode, check voltage on idle air control motor connector, No. 1 driver circuit (Brown/White wire) while momentarily opening and closing throttle. If voltage is less than one volt, go to TEST NF-8B. If voltage is more than one volt, go to next step.

3) Using DRB-II, check voltage on idle air control motor connector, No. 2 driver circuit (Yellow/Black wire on XJ and YJ bodies or Violet/Black wire on ZJ body) while momentarily opening and closing throttle. If voltage is less than one volt, go to TEST NF-8B. If voltage is more than one volt, go to next step.

4) Using DRB-II, check voltage on idle air control motor connector, No. 3 driver circuit (Gray/Red wire on XJ and YJ bodies or Yellow/Black wire on ZJ body) while momentarily opening and closing throttle. If voltage is less than one volt, go to TEST NF-8B. If voltage is more than one volt, go to next step.

5) Using DRB-II, check voltage on idle air control motor connector, No. 4 driver circuit (Violet/Black wire on XJ and YJ bodies or Gray/Red wire on ZJ body) while momentarily opening and closing throttle. If voltage is less than one volt, go to TEST NF-8B. If voltage is more than one volt, go to next step.

6) Check engine for vacuum leaks. Repair as necessary. Perform TEST VER-1. If no vacuum leaks are observed, replace idle air control motor. Perform TEST VER-1.

## TEST NF-8B - CHECKING IDLE AIR CONTROL MOTOR

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

Turn engine off. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance of each wire between Idle Air Control (IAC) motor connector and PCM connector. See appropriate PCM TERMINAL IDENTIFICATION table. If resistance for any wire is more than 10 ohms, repair open on necessary wire. Perform TEST VER-1. If resistance for any wire is less than 10 ohms, replace PCM. Perform TEST VER-1.

### PCM TERMINAL IDENTIFICATION TABLE (XJ & YJ BODIES)

Wire Color	Terminal No.
Gray/Red	39

Brown/White .....	40
Violet/Black .....	59
Yellow/Black .....	60

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PCM TERMINAL IDENTIFICATION TABLE (ZJ BODY)

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Wire Color	Terminal No.
Yellow/Black .....	39
Brown/White .....	40
Gray/Red .....	59
Violet/Black .....	60

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### TEST NF-9A - CHECKING PARK/NEUTRAL SWITCH

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, read park/neutral switch input state. While watching DRB-II display, move gear selector in and out of Park and Reverse positions. If display shows P/N and D/R, system is functioning properly. Test is complete. If display does not show P/N and D/R, go to next step.

2) Turn ignition off. Place gear selector in Park position. Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance on PCM connector terminal No. 30, park/neutral switch sense circuit (Brown/Yellow wire). Observe DRB-II display while moving gear selector in and out of Park and Reverse positions.

3) If display switches from less than 5 ohms to more than 5 ohms, replace PCM. Perform TEST VER-1. If display does not switch from less than 5 ohms to more than 5 ohms, check if display always stays less than 5 ohms. If display always stays less than 5 ohms, repair short to ground in Brown/Yellow wire. Perform TEST VER-1. If display does not always stay less than 5 ohms, go to next step.

4) Disconnect park/neutral switch connector. Using an external ohmmeter, check resistance of sense circuit (Brown/Yellow wire) between park/neutral switch connector and PCM connector terminal No. 30. If resistance is less than 10 ohms, replace park/neutral switch. Perform TEST VER-1. If resistance is more than 10 ohms, repair open in Brown/Yellow wire. Perform TEST VER-1.

### TEST NF-10A - CHECKING PCM GROUND & POWER CIRCUITS

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 5, signal ground circuit (Black/White wire on XJ and YJ bodies or Black/Tan wire on ZJ body). If resistance is more than 5 ohms, repair open in Black/White wire on XJ and YJ bodies or Black/Tan wire on ZJ body. Perform TEST VER-1. If resistance is less than 5 ohms, go to next step.

2) Using DRB-II, check resistance of PCM connector terminal No. 11, power ground circuit (Black/Tan wire on XJ and ZJ bodies or Black wire on YJ body). If resistance is more than 5 ohms, repair open



in Black/Tan wire on XJ and ZJ bodies or Black wire on YJ body. Perform TEST VER-1. If resistance is less than 5 ohms, go to next step.

3) Using DRB-II, check resistance of PCM connector terminal No. 12, power ground circuit (Black/Tan wire on XJ and ZJ bodies or Black wire on YJ body). If resistance is more than 5 ohms, repair open in Black/Tan wire on XJ and ZJ bodies or Black wire on YJ body. Perform TEST VER-1. If resistance is less than 5 ohms, reconnect PCM connector. PCM grounds and power circuits are okay.

## TEST NF-11A - CHECKING ENGINE VACUUM

Connect a vacuum gauge to engine. Start engine, and let it idle. Normal vacuum reading will vary depending on altitude. Observe vacuum gauge at idle. If vacuum gauge reading is not steady 13-22 in. Hg, perform TEST NF-12A. If vacuum gauge reading is steady 13-22 in. Hg, engine vacuum is normal. Test is complete.

## TEST NF-12A - NO FAULT CODE MECHANICAL TEST

NOTE: If coming to this test from O2 sensor test and rich or lean condition is not corrected after checking items listed below, replace Powertrain Control Module (PCM).

At this point in diagnostic test procedure, all engine control systems have been determined to be operating as designed and not causing a driveability problem. Following additional items should be checked as possible causes:

- \* Check if any MITCHELL(R) TECH SERVICE BULLETINS (TSBs) apply to vehicle.
- \* Check engine compression.
- \* Check for exhaust system restriction.
- \* Check camshaft and crankshaft sprockets.
- \* Check valve timing.
- \* Check torque converter stall speed.
- \* Check engine vacuum. It must be at least 13 in. Hg in Neutral.
- \* Check for fuel contamination.
- \* Ensure PCV system is functioning properly.
- \* Ensure injector control circuit is connected to correct fuel injector and injector is not plugged or restricted.
- \* Check power booster for internal vacuum leak.

## TEST NS-1A - QUALIFYING NO-START CONDITION

CAUTION: When checking for spark, Powertrain Control Module (PCM) damage may occur if spark plug cable is held more than 1/4" away from ground.

1) Turn ignition off. Disconnect any spark plug cable at spark plug. Insert an insulated screwdriver in spark plug cable terminal. Hold screwdriver within 1/4" of ground.

NOTE: When checking for spark, consider one or 2 sparks as a no-spark condition.

2) While cranking engine for 10 seconds, watch for spark. If a good spark occurs, go to TEST NS-2A. If a good spark does not occur, reconnect spark plug cable. Disconnect another spark plug cable at spark plug, and repeat test.

3) If a good spark occurs, go to TEST NS-2A. If a good spark does not occur, turn ignition off. Remove coil cable from distributor

cap. Hold cable within 1/4" of ground. While cranking engine for 10 seconds, watch for spark. If good spark does not occur, go to next step. If good spark occurs, repair distributor cap, rotor or spark plug cables as necessary. Perform TEST VER-1.

4) Turn ignition off. Remove coil cable from coil. Using an external ohmmeter, check resistance of coil cable. If resistance is more than 15,000 ohms, replace coil cable. If resistance is less than 15,000 ohms, remove distributor cap. While cranking engine, watch distributor rotor. If distributor rotor turns, go to next step. If distributor rotor does not turn, repair distributor drive system as necessary. Perform TEST VER-1.

5) Install distributor cap and coil cable. Disconnect ignition coil connector. Inspect ignition coil connector for damaged or pushed-out terminals. Repair as necessary. Perform TEST VER-1. If ignition coil connector terminals are okay, go to next step.

6) Turn ignition on. Using DRB-II, actuate ASD fuel system. While actuating ASD fuel system, put DRB-II in voltmeter mode. Using DRB-II, check voltage on ASD relay connector output circuit (Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body). If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open in Dark Green/Orange wire on XJ and YJ bodies or Dark Green/Black wire on ZJ body. Perform TEST VER-1.

7) Using DRB-II, check voltage on ASD relay connector ignition coil driver circuit (Gray wire on XJ and YJ bodies or Gray/White wire on ZJ body). If voltage is more than 10 volts, replace ignition coil. Perform TEST VER-1. If voltage is less than 10 volts, turn ignition off. Go to next step.

8) Disconnect Powertrain Control Module (PCM) connector. Using DRB-II in ohmmeter mode, check resistance at terminal No. 19 of PCM connector (Gray wire on XJ and YJ bodies or Gray/White wire on ZJ body). If resistance is more than 5 ohms, go to next step. If resistance is less than 5 ohms, repair short to ground in Gray wire on XJ and YJ bodies or Gray/White wire on ZJ body. Perform TEST VER-1.

9) Using an external ohmmeter, check resistance between ignition coil connector (Gray wire on XJ and YJ bodies or Gray/White wire on ZJ body), and PCM connector terminal No. 19. If resistance is more than 5 ohms, repair open in Gray wire on XJ and YJ bodies or Gray/White wire on ZJ body. Perform TEST VER-1. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1.

## TEST NS-2A - INSPECTING FUEL SYSTEM

**WARNING:** High fuel pressure may be present in fuel lines. Open fuel system with caution. See FUEL PRESSURE RELEASE procedure.

1) Ensure throttle cables are not holding throttle open. If throttle is held open, repair as necessary. Perform TEST VER-1. If throttle is not held open, using DRB-II, read Throttle Position Sensor (TPS) voltage.

2) If voltage is less than 1.5 volts, go to next step. If voltage is more than 1.5 volts, disconnect TPS connector. Inspect terminals. Repair as necessary. Perform TEST VER-1. If terminals are okay, replace TPS. Perform TEST VER-1.

3) If vehicle is not equipped with a factory vehicle theft alarm, go to next step. If vehicle is equipped with factory vehicle theft alarm, using DRB-II, read theft alarm status. If DRB-II displays FUEL ON, go to next step. If DRB-II does not display FUEL ON, see G - BODY TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

4) Using DRB-II, actuate fuel system. Listen for fuel pump operation at fuel tank. If fuel pump operation cannot be heard, go to TEST NS-5A. If fuel pump operation can be heard, turn ignition off.

5) Ensure fuel tank is at least 1/4 full. Release fuel pressure. Install a fuel pressure gauge in fuel supply line. Turn

ignition on. Using DRB-II, actuate fuel system. Read fuel pressure gauge reading.

6) If fuel pressure is more than 43 psi (3.0 kg/cm<sup>2</sup>), go to TEST NS-4B. If fuel pressure is not more than 43 psi (3.0 kg/cm<sup>2</sup>), go to next step.

7) If pressure is less than 34 psi (2.3 kg/cm<sup>2</sup>), go to TEST NS-4A. If pressure is more than 34 psi (2.3 kg/cm<sup>2</sup>), go to next step.

8) If vehicle initially started and stalled repeatedly, go to TEST NS-7A. If vehicle did not initially start and stall repeatedly, go to TEST NS-3A.

## TEST NS-3A - INSPECTING MECHANICAL SYSTEM

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Disconnect Manifold Absolute Pressure (MAP) sensor connector. Turn ignition on. Using DRB-II in voltmeter mode, check voltage on MAP sensor connector, 5-volt supply circuit (Violet/White wire). If voltage is less than 4.5 volts, repair open in Violet/White wire. Perform TEST VER-1.

2) If voltage is more than 4.5 volts, reconnect MAP sensor connector. Remove all spark plugs. Inspect spark plug tips for wet fuel. If spark plug tips are wet, clean and reinstall spark plugs. If spark plug tips are not wet, reinstall spark plugs. Turn ignition on.

3) Using DRB-II, read total spark advance while cranking engine. If spark advance is not 0-25 degrees BTDC, replace Powertrain Control Module (PCM). Perform TEST VER-1.

4) If spark advance is 0-25 degrees BTDC, inspect spark plug cables for correct placement. Reposition cables as necessary. Perform TEST VER-1. If spark plug cables are okay, turn ignition off. Check valve timing. Correct valve timing as necessary. Perform TEST VER-1.

5) If valve timing is okay, check engine compression. Repair as necessary. Perform TEST VER-1. If engine compression is okay, replace MAP sensor. Perform TEST VER-1.

## TEST NS-4A - CORRECTING FUEL DELIVERY

WARNING: High fuel pressure may be present in fuel lines. Open fuel system with caution. See FUEL PRESSURE RELEASE procedure.

1) Record fuel pressure gauge reading. Turn ignition off. Release fuel pressure. Remove fuel pressure gauge. Install fuel pressure gauge between fuel tank and fuel filter. Turn ignition on.

2) Using DRB-II, actuate Auto Shutdown (ASD) fuel system. Record fuel pressure gauge reading. Compare fuel pressure gauge reading with previous reading. If fuel pressure gauge reading is not at least 10 psi more than previous reading, go to step 4). If fuel pressure gauge reading is at least 10 psi more than previous reading, turn ignition off.

3) Inspect fuel lines between fuel filter and fuel rail for restriction. Repair as necessary. Perform TEST VER-1. If no restrictions are observed, replace fuel filter. Perform TEST VER-1.

4) Disconnect fuel return hose at fuel rail. Connect a 6-foot fuel hose to fuel rail. Put other end of 6-foot hose into an approved 2-gallon or more capacity gasoline container. Turn ignition on. Using DRB-II, actuate fuel system.

CAUTION: DO NOT allow fuel pressure to exceed 70 psi (4.9 kg/cm<sup>2</sup>) when squeezing fuel return hose.

5) Gently squeeze fuel return hose. Read fuel pressure gauge. Using DRB-II, stop fuel system actuator test. If pressure is more than 34 psi (2.3 kg/cm<sup>2</sup>), replace fuel pressure regulator. Perform TEST VER-1. If it is less than 34 psi (2.3 kg/cm<sup>2</sup>), replace fuel pump and sock filter. Perform TEST VER-1.

## TEST NS-4B - CORRECTING FUEL DELIVERY

**WARNING:** High fuel pressure may be present in fuel lines. Open fuel system with caution. See FUEL PRESSURE RELEASE procedure.

1) Ensure fuel tank is at least 1/4 full. Release fuel pressure. Turn ignition off. Disconnect fuel return hose from fuel rail. Connect a 6-foot fuel hose to fuel rail. Put other end of 6-foot hose into an approved 2-gallon or more capacity gasoline container.

2) Turn ignition on. Using DRB-II, actuate fuel system. If pressure is less than 43 psi (3.0 kg/cm<sup>2</sup>), go to next step. If pressure is more than 43 psi (3.0 kg/cm<sup>2</sup>), replace fuel pressure regulator. Perform TEST VER-1.

3) Stop fuel system actuation. Turn ignition off. Reconnect fuel return hose. Remove fuel return hose from fuel tank. Connect Fuel Pressure Test Adapter (C-6541) to disconnected return hose.

4) Put other end of adapter hose into an approved 2-gallon or more capacity gasoline container. Turn ignition on. Using DRB-II, actuate fuel system. Read fuel pressure gauge. Using DRB-II stop actuation test.

5) If pressure is less than 43 psi (3.0 kg/cm<sup>2</sup>), repair restricted fuel pump. Perform TEST VER-1. If pressure is more than 43 psi (3.0 kg/cm<sup>2</sup>), repair restricted fuel return line between fuel rail and fuel tank. Perform TEST VER-1.

## TEST NS-5A - INSPECTING FUEL PUMP

**NOTE:** For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Using DRB-II, stop actuation test. Using DRB-II, actuate Auto Shutdown (ASD) relay. Touch fuel pump relay. If fuel pump relay does not pulsate when actuated, go to TEST NS-5B. If fuel pump relay pulsates when actuated, turn ignition off.

2) Disconnect fuel pump relay. Using DRB-II in voltmeter mode, check voltage on fuel pump relay connector, battery voltage circuit (Red wire on XJ and ZJ bodies or Red/White wire on YJ body). If voltage is less than 10 volts, repair open circuit in Red wire on XJ and ZJ bodies or Red/White wire on YJ body. Perform TEST VER-1. If voltage is more than 10 volts, reconnect fuel pump relay.

3) Disconnect fuel pump harness connector. Ensure fuel pump connector has clean and tight connections. Turn ignition on. Using DRB-II, actuate fuel system. While still actuating, put DRB-II in voltmeter mode. Using DRB-II, check voltage on fuel pump connector, output wire (Dark Green/Orange wire on XJ body, Dark Green/Black wire on YJ body or Orange/Black wire on ZJ body). If voltage is less than 10 volts, go to step 5). If voltage is more than 10 volts, stop actuation test.

4) Using DRB-II in ohmmeter mode, check resistance of fuel pump connector, ground circuit (Black wire on XJ and ZJ bodies or Black/Orange wire on YJ body). If resistance is more than 5 ohms, repair open in Black wire on XJ and ZJ bodies or Black/Orange wire on YJ body. Perform TEST VER-1. If resistance is less than 5 ohms, replace fuel pump. Perform TEST VER-1.

5) Turn ignition off. Disconnect fuel pump relay. Connect a

jumper wire between fuel pump relay connector, output circuit (Dark Green/Orange wire on XJ body, Dark Green/Black wire on YJ body or Orange/Black wire on ZJ body) and ground.

6) Using DRB-II in ohmmeter mode, check resistance of fuel pump connector, output circuit (Dark Green/Black wire on XJ and YJ bodies or Orange/Dark Blue wire on ZJ body). If resistance is less than 5 ohms, replace fuel pump relay. Perform TEST VER-1. On YJ and ZJ bodies, if resistance is more than 5 ohms, repair open in Dark Green/Black wire on YJ body or Orange/Dark Blue wire on ZJ body. Perform TEST VER-1.

7) On XJ body, disconnect ballast resistor. Using an external ohmmeter, check resistance of ballast resistor. If resistance is more than 5 ohms, replace ballast resistor. Perform TEST VER-1. If resistance is less than 5 ohms, repair open in Dark Green/Orange wire. Perform TEST VER-1.

## TEST NS-5B - INSPECTING FUEL PUMP

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Stop actuation test. Turn ignition off. Disconnect fuel pump relay. Turn ignition on. Using DRB-II, check voltage on fuel pump relay connector, ignition 12-volt supply circuit (Dark Blue wire on XJ body, White/Yellow wire on YJ body or Light Blue/Red wire on ZJ body).

2) If voltage is less than 10 volts, repair open in Dark Blue wire on XJ body, White/Yellow wire on YJ body or Light Blue/Red wire on ZJ body. Perform TEST VER-1. If voltage is more than 10 volts, go to next step.

3) Using an external ohmmeter, check resistance across fuel pump relay terminals. See CONNECTOR IDENTIFICATION at beginning of article. If resistance is more than 100 ohms, replace fuel pump relay. Perform TEST VER-1. If resistance is less than 100 ohm, repair open in Dark Blue/Yellow wire on XJ and YJ bodies or Pink wire on ZJ body. Perform TEST VER-1.

## TEST NS-6A - CORRECTING NO RESPONSE CONDITION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) If vehicle starts, go to TEST NS-6B. If vehicle does not start, turn ignition off. Disconnect Throttle Position Sensor (TPS) connector. Turn ignition on.

2) Using DRB-II in voltmeter mode, check voltage on TPS connector, 5-volt supply circuit (Violet/White wire). If voltage is more than 6 volts, repair open ground circuits at Powertrain Control Module (PCM) connector terminals No. 5 (Black/White wire on XJ and YJ bodies or Black/Tan wire on ZJ body), No. 11 and No. 12 (Black/Tan wire on XJ and ZJ bodies or Black wire on YJ body). Perform TEST VER-1. If voltage is less than 6 volts, go to next step.

3) If voltage is less than 4.4 volts, go to step 5). If voltage is more than 4.4 volts, reconnect TPS connector. Disconnect Manifold Absolute Pressure (MAP) sensor connector.

4) Using DRB-II, check voltage on MAP sensor connector, 5-volt supply circuit (Violet/White wire). If voltage is more than 4.4 volts, go to TEST NS-6B. If voltage is less than 4.4 volts, replace TPS. Perform TEST VER-1.

5) Disconnect MAP sensor electrical connector. Using DRB-II,

check voltage on TPS connector, 5-volt supply circuit (Violet/White wire). If voltage is more than 4.4 volts, replace MAP sensor. Perform TEST VER-1.

6) If voltage is less than 4.4 volts, turn ignition off. Disconnect PCM connector. Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 6, 5-volt supply circuit (Violet/White wire).

7) If resistance is less than 5 ohms, repair short to ground in Violet/White wire. Perform TEST VER-1. If resistance is more than 5 ohms, turn ignition on. Using DRB-II in voltmeter mode, check voltage on PCM connector terminal No. 9, ignition 12-volt feed circuit (Dark Blue wire on XJ body, White/Yellow wire on YJ body or Light Blue/Red wire on ZJ body).

8) If voltage is more than 10 volts, go to next step. If voltage is less than 10 volts, repair open in Dark Blue wire on XJ body, White/Yellow wire on YJ body or Light Blue/Red wire on ZJ body between PCM connector and ignition switch. Perform TEST VER-1.

9) Using DRB-II, check voltage on PCM connector terminal No. 3, battery voltage circuit (Red wire on XJ and ZJ bodies or Red/White wire on YJ body). If voltage is less than 10 volts, go to next step. If voltage is more than 10 volts, replace PCM. Perform TEST VER-1.

10) Remove engine control fuse from Power Distribution Center (PDC). Inspect fuse. If fuse is okay, go to next step. If fuse is blown, go to step 12). Using DRB-II in voltmeter mode, check voltage on battery voltage side of PDC engine control fuse socket.

11) If voltage is more than 10 volts, repair open in Red wire on XJ and ZJ bodies or Red/White wire on YJ body between PDC engine control fuse socket and PCM connector terminal No. 3. Perform TEST VER-1. If voltage is less than 10 volts, repair open in battery voltage side of PDC engine control fuse socket. Perform TEST VER-1.

12) Turn ignition off. Disconnect Auto Shutdown (ASD) and fuel pump relays. Using DRB-II in ohmmeter mode, check resistance of PCM connector terminal No. 3, fused battery voltage circuit (Red wire on XJ and ZJ bodies or Red/White wire on YJ body). If resistance is less than 5 ohms, repair short to ground in Red wire on XJ and ZJ bodies or Red/White wire on YJ body. Perform TEST VER-1.

13) If resistance is more than 5 ohms, check resistance of ASD relay connector, output circuit (Dark Green/Orange wire). If resistance is less than 5 ohms, go to next step. If resistance is more than 5 ohms, perform TEST NS-6C.

14) Disconnect ignition coil connector. Using DRB-II, check resistance of ASD relay connector, output circuit (Dark Green/Orange wire). If resistance is more than 5 ohms, replace ignition coil. Perform TEST VER-1.

15) If resistance is less than 5 ohms, disconnect generator field connector. Using DRB-II, check resistance of ASD relay connector, output circuit (Dark Green/Orange wire). If resistance is more than 5 ohms, repair short to ground in generator. Perform TEST VER-1.

16) If resistance is less than 5 ohms, disconnect No. 1 fuel injector harness connector. Using DRB-II, check resistance of ASD relay connector, output circuit (Dark Green/Orange wire). If resistance is more than 5 ohms, replace No. 1 fuel injector. Perform TEST VER-1.

17) If resistance is less than 5 ohms, perform previous step for each additional fuel injector in order. After all injectors have been tested, if resistance is less than 5 ohms, repair short to ground in Dark Green/Orange wire. Perform TEST VER-1.

## TEST NS-6B - CORRECTING NO RESPONSE CONDITION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams,

see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) If ignition was not on when NO RESPONSE message was displayed, turn ignition on to get a response. If ignition was on when NO RESPONSE message was displayed, turn ignition off.

2) Disconnect DRB-II from engine diagnostic connector. Disconnect Powertrain Control Module (PCM) connector. Using an external ohmmeter, check resistance between engine diagnostic connector, SCI transmit circuit (Pink wire on XJ and YJ bodies or Black wire on ZJ body) and ground.

3) If resistance is less than 5 ohms, repair short to ground in Pink wire on XJ and YJ bodies or Black wire on ZJ body. Perform TEST VER-1. If resistance is more than 5 ohms, using an external ohmmeter, check resistance between engine diagnostic connector, SCI receive circuit (Light Green wire on XJ and YJ bodies or Black/Yellow wire on ZJ body), and ground.

4) If resistance is less than 5 ohms, repair short to ground in Light Green wire on XJ and YJ bodies or Black/Yellow wire on ZJ body. Perform TEST VER-1. If resistance is more than 5 ohms, go to next step.

5) Using an external ohmmeter, check resistance of SCI transmit circuit (Pink wire on XJ and YJ bodies or Black wire on ZJ body) between engine diagnostic connector and PCM connector terminal No. 25. If resistance is more than 5 ohms, repair open in Pink wire on XJ and YJ bodies or Black wire on ZJ body. Perform TEST VER-1.

6) If resistance is less than 5 ohms, using an external ohmmeter, check resistance of SCI receive circuit (Light Green wire on XJ and YJ bodies or Black/Yellow wire on ZJ body) between engine diagnostic connector and PCM connector terminal No. 45. If resistance is more than 5 ohms, repair open in Light Green wire on XJ and YJ bodies or Black/Yellow wire on ZJ body. Perform TEST VER-1.

7) If resistance is less than 5 ohms, connect DRB-II to a functional engine diagnostic connector on another vehicle. Turn ignition on. Using DRB-II, attempt to read fault messages. If DRB-II does not display NO RESPONSE, replace PCM on initial vehicle. Perform TEST VER-1.

8) If DRB-II displays NO RESPONSE, substitute another DRB-II cartridge. Using DRB-II, attempt to read fault messages. If DRB-II does not display NO RESPONSE, replace DRB-II cartridge. If DRB-II displays NO RESPONSE, substitute another DRB-II adapter cable. Using DRB-II, attempt to read fault messages. If DRB-II does not display NO RESPONSE, replace DRB-II adapter cable. If DRB-II displays NO RESPONSE, replace DRB-II or cartridge.

## TEST NS-6C - CORRECTING NO RESPONSE CONDITION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Disconnect fuel pump connector and oxygen sensor connector. Using DRB-II, check resistance of fuel pump connector, output circuit (Dark Green/Black wire on XJ and YJ bodies or Orange/Dark Blue wire on ZJ body). If resistance is less than 5 ohms, repair short to ground in Dark Green/Black wire on XJ and YJ bodies or Orange/Dark Blue wire on ZJ body. Perform TEST VER-1.

2) If resistance is more than 5 ohms, using DRB-II, check resistance of oxygen sensor connector, relay output circuit (White wire). If resistance is more than 5 ohms, replace fuel pump. Perform TEST VER-1. If resistance is less than 5 ohms, replace oxygen sensor. Perform TEST VER-1.

## TEST NS-7A - INSPECTING IDLE AIR CONTROL MOTOR OPERATION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Disconnect Idle Air Control (IAC) motor connector. Turn ignition on. Using DRB-II, actuate IAC motor. Using DRB-II in voltmeter mode, check voltage on IAC motor connector, No. 3 driver circuit (Gray/Red wire on XJ and YJ bodies or Yellow/Black wire on ZJ body). If voltage is less than one volt, go to TEST NS-7B.

2) If voltage is more than one volt, check voltage on IAC motor connector, No. 1 driver circuit (Brown/White wire). If voltage is less than one volt, go to TEST NS-7C. If voltage is more than one volt, check voltage on IAC motor connector, No. 4 driver circuit (Violet/Black wire on XJ and YJ bodies or Gray/Red wire on ZJ body). If voltage is less than one volt, go to TEST NS-7D.

3) If voltage is more than one volt, check voltage on IAC motor connector, No. 2 driver circuit (Yellow/Black wire on XJ and YJ bodies or Violet/Black wire on ZJ body). If voltage is less than one volt, go to TEST NS-7E. If voltage is more than one volt, turn ignition off.

4) Remove IAC motor from throttle body. Reconnect IAC motor connector. Using DRB-II, actuate IAC motor. If IAC motor tip moves in and out, go to TEST NS-8A. If IAC motor tip does not move in and out, replace IAC motor. Perform TEST VER-1.

## TEST NS-7B - INSPECTING IDLE AIR CONTROL MOTOR OPERATION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Inspect all terminals. Repair as necessary. Perform TEST VER-1. If PCM terminals are okay, go to next step.

2) Using an external ohmmeter, check resistance of No. 3 driver circuit (Gray/Red wire on XJ and YJ bodies or Yellow/Black wire on ZJ body) between IAC motor connector and PCM connector terminal No. 39. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in Gray/Red wire on XJ and YJ bodies or Yellow/Black wire on ZJ body. Perform TEST VER-1.

## TEST NS-7C - INSPECTING IDLE AIR CONTROL MOTOR OPERATION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Inspect all terminals. Repair as necessary. Perform TEST VER-1. If PCM terminals are okay, go to next step.

2) Using an external ohmmeter, check resistance of No. 1 driver circuit (Brown/White wire) between IAC motor connector and PCM connector terminal No. 40. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in Brown/White wire. Perform TEST VER-1.



## TEST NS-7D - INSPECTING IDLE AIR CONTROL MOTOR OPERATION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Inspect all terminals. Repair as necessary. Perform TEST VER-1. If PCM terminals are okay, go to next step.

2) Using an external ohmmeter, check resistance of No. 4 driver circuit (Violet/Black wire on XJ and YJ bodies or Gray/Red wire on ZJ body) between IAC motor connector and PCM connector terminal No. 59. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in Violet/Black wire on XJ and YJ bodies or Gray/Red wire on ZJ body. Perform TEST VER-1.

## TEST NS-7E - INSPECTING IDLE AIR CONTROL MOTOR OPERATION

NOTE: For connector terminal identification, see CONNECTOR IDENTIFICATION at beginning of article. For wiring diagrams, see L - WIRING DIAGRAMS article in the ENGINE PERFORMANCE Section.

1) Turn ignition off. Disconnect Powertrain Control Module (PCM) connector. Inspect all terminals. Repair as necessary. Perform TEST VER-1. If PCM terminals are okay, go to next step.

2) Using an external ohmmeter, check resistance of No. 2 driver circuit (Yellow/Black wire on XJ and YJ bodies or Violet/Black wire on ZJ body) between IAC motor connector and PCM connector terminal No. 60. If resistance is less than 5 ohms, replace PCM. Perform TEST VER-1. If resistance is more than 5 ohms, repair open in Yellow/Black wire on XJ and YJ bodies or Violet/Black wire on ZJ body. Perform TEST VER-1.

## TEST NS-8A - CORRECTING START & STALL CONDITION

At this point in diagnostic test procedure, all engine control systems have been determined to be operating as designed and not causing a start and stall problem. Check following items as possible causes:

- \* Check if any MITCHELL(R) TECH SERVICE BULLETINS (TSBs) apply to vehicle.
- \* Check engine compression.
- \* Check for exhaust system restriction.
- \* Check camshaft and crankshaft sprockets.
- \* Check valve timing.
- \* Check for fuel contamination.
- \* Check secondary ignition system.
- \* Ensure PCV system is functioning properly.

## TEST VER-1 - VERIFICATION TEST VER-1

1) Inspect vehicle to ensure all engine components are connected. Reassemble and reconnect components as necessary. Inspect engine oil for fuel contamination. Change oil and filter if necessary. Attempt to start engine.

2) If engine does not start, check if any MITCHELL(R) TECH SERVICE BULLETINS (TSBs) apply to vehicle and return to TEST FC-1A, if necessary.

3) If engine starts and Powertrain Control Module (PCM) was

changed, repair is complete.

4) If engine starts and PCM was not changed, connect DRB-II to engine diagnostic connector and erase fault messages. Repair is complete.

## TEST VER-2 - VERIFICATION TEST VER-2

Inspect vehicle to ensure all engine components are connected. Reassemble and reconnect components as necessary. If another fault was read previously and not corrected, return to TEST FC-1A and follow path specified by other fault. If Powertrain Control Module (PCM) has not been replaced, perform following:

- \* Connect DRB-II to engine diagnostic connector, and erase faults.
- \* Using DRB-II, reset all values in adaptive memory.
- \* Disconnect DRB-II.

To ensure no other fault remains, perform following:

1) If vehicle is equipped with A/C, turn on A/C and blower motor. Drive vehicle for at least 5 minutes and attain a speed of at least 40 MPH. Ensure transmission shifts through all gears.

2) Upon completion of road test, turn engine off. Restart engine and let idle for at least 2 minutes. Turn engine off. Connect DRB-II to engine diagnostic connector.

3) Read all fault messages. If repaired fault has reset, repair is not complete. Check all pertinent MITCHELL(R) TECH SERVICE BULLETINS (TSBs), and return to TEST FC-1A if necessary. If another fault exists, return to TEST FC-1A and follow path specified by other fault. If no other faults exist, repair is now complete.

# GEAR TOOTH CONTACT PATTERNS

1993 Jeep Cherokee

## GENERAL INFORMATION Gear Tooth Contact Patterns

### **\* PLEASE READ THIS FIRST \***

The following article is for GENERAL INFORMATION purposes only. Information does not SPECIFICALLY apply to all years, makes and models, but is to be used as a general reference guide.

## **INSPECTION**

### **PRELIMINARY INSPECTION**

Wipe lubricant from internal parts. Rotate gears and inspect for wear or damage. Mount dial indicator to housing, and check backlash at several points around ring gear. Backlash must be within specifications at all points. If no defects are found, check gear tooth contact pattern.

### **GEAR TOOTH CONTACT PATTERN**

NOTE: Drive pattern should be well centered on ring gear teeth. Coast pattern should be centered, but may be slightly toward toe of ring gear teeth.

1) Paint ring gear teeth with marking compound. Wrap cloth or rope around drive pinion flange to act as brake. Rotate ring gear until clear tooth contact pattern is obtained.

2) Contact pattern will indicate whether correct pinion bearing mounting shim has been installed and if drive gear backlash has been set properly. Backlash between drive gear and pinion must be maintained within specified limits, until correct tooth pattern is obtained.

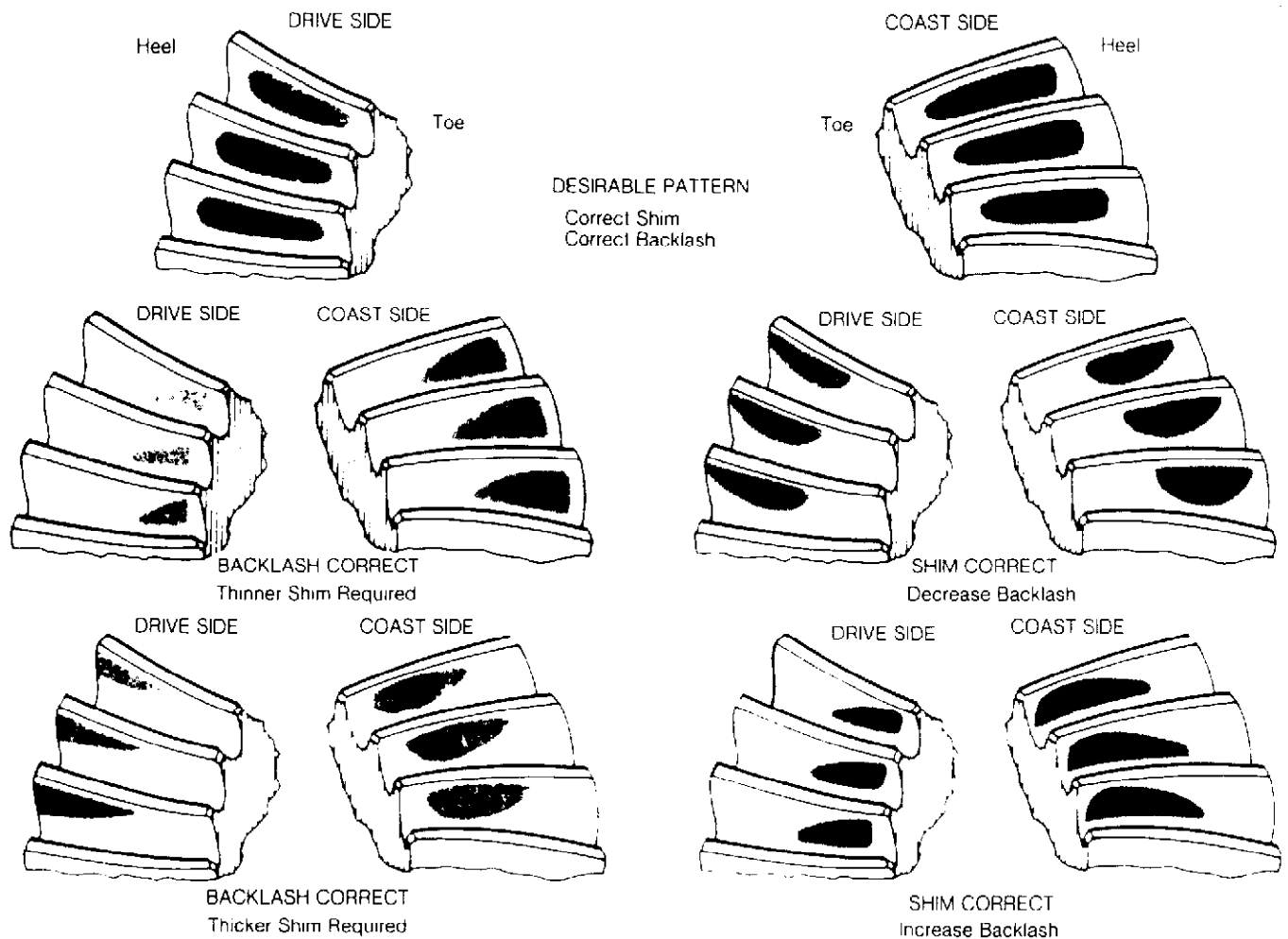


Fig. 1: Drive Axle Gear Tooth Patterns

## ADJUSTMENTS

### GEAR BACKLASH & PINION SHIM CHANGES

**NOTE:** Backlash is adjusted by either moving shims from one side of differential case to the other or by turning adjusting nuts on which side bearing races ride. Changing of pinion shims alters the distance from face of pinion of centerline of ring gear.

1) With no change in backlash, moving pinion further from ring gear moves drive pattern toward heel and top of tooth, and moves coast pattern toward toe and top of tooth.

2) With no change in backlash, moving pinion closer to ring gear moves drive pattern toward toe and bottom of tooth, and moves coast pattern toward heel and bottom of tooth.

3) With no change in pinion shim thickness, an increase in backlash moves ring gear further from pinion. Drive pattern moves toward heel and top of tooth, and coast pattern moves toward heel and top of tooth.

4) With no change in pinion shim thickness, decrease in

backlash moves ring gear closer to pinion gear. Drive pattern moves toward toe and bottom of tooth, and coast pattern moves toward toe and bottom of tooth.

# GENERAL COOLING SYSTEM SERVICING

1993 Jeep Cherokee

GENERAL INFORMATION  
General Cooling System Servicing

## \* PLEASE READ THIS FIRST \*

The following article is for general information only. Information may not apply to all years, makes and models. See specific article in the ENGINE COOLING section.

## DESCRIPTION

The basic liquid cooling system consists of a radiator, water pump, thermostat, electric or belt-driven cooling fan, pressure cap, heater, and various connecting hoses and cooling passages in the block and cylinder head.

## MAINTENANCE

### DRAINING

Remove radiator cap and open heater control valve to maximum heat position. Open drain cocks or remove plugs in bottom of radiator and engine block. In-line engines usually have one plug or drain cock, while "V" type engines will have 2, one in each bank of cylinders.

### CLEANING

A good cleaning compound removes most rust and scale. Follow manufacturer's instructions in the use of cleaner. If considerable rust and scale has to be removed, cooling system should be flushed. Clean radiator air passages with compressed air.

### FLUSHING

**CAUTION:** Some manufacturers use an aluminum and plastic radiator. Flushing solution must be compatible with aluminum.

#### Back Flushing

Back flushing is an effective means of removing cooling system rust and scale. The radiator, engine and heater core should be flushed separately.

#### Radiator

To flush radiator, connect flushing gun to water outlet of radiator and disconnect water inlet hose. To prevent flooding engine, use a hose connected to radiator inlet. Use air in short bursts to prevent damage to radiator. Continue flushing until water runs clear.

#### Engine

To flush engine, remove thermostat and replace housing. Connect flushing gun to water outlet of engine. Flush using short air bursts until water runs clean.

#### Heater Core

Flush heater core as described for radiator. Ensure heater control valve is set to maximum heat position before flushing heater.

## REFILLING

To prevent air from being trapped in engine block, engine should be running when refilling cooling system. After system is full, continue running engine until thermostat is open, then recheck fill level. Do not overfill system.

## TESTING

### THERMOSTAT

1) Visually inspect thermostat for corrosion and proper sealing of valve and seat. If okay, suspend thermostat and thermometer in a 50/50 mixture of coolant and water. See Fig. 1. Do not allow thermostat or thermometer to touch bottom of container. Heat water until thermostat just begins to open.

2) Read temperature on thermometer. This is the initial opening temperature and should be within specification. Continue heating water until thermostat is fully open and note temperature. This is the fully opened temperature. If either reading is not to specification, replace thermostat.

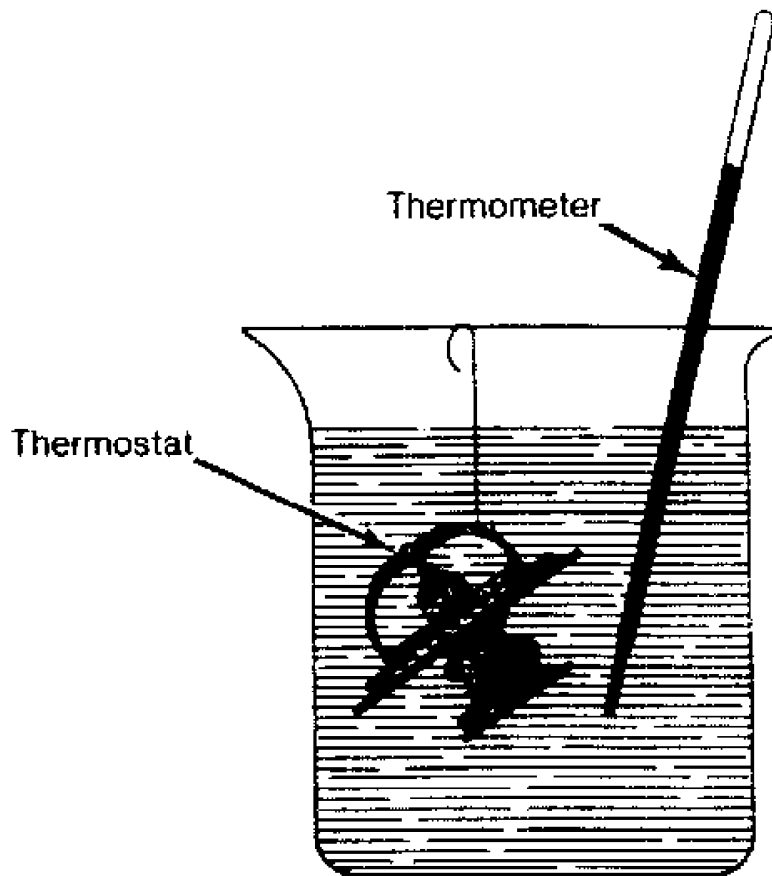


Fig. 1: Testing Thermostat in Anti-Freeze/Water Solution

### PRESSURE TESTING

A pressure tester is used to check both radiator cap and

complete cooling system. Test components as follows, following tool manufacturer's instructions.

#### Radiator Cap

Visually inspect radiator cap, then dip cap into water and connect to tester. Pump tester to bring pressure to upper limit of cap specification. If cap fails to hold pressure, replace cap.

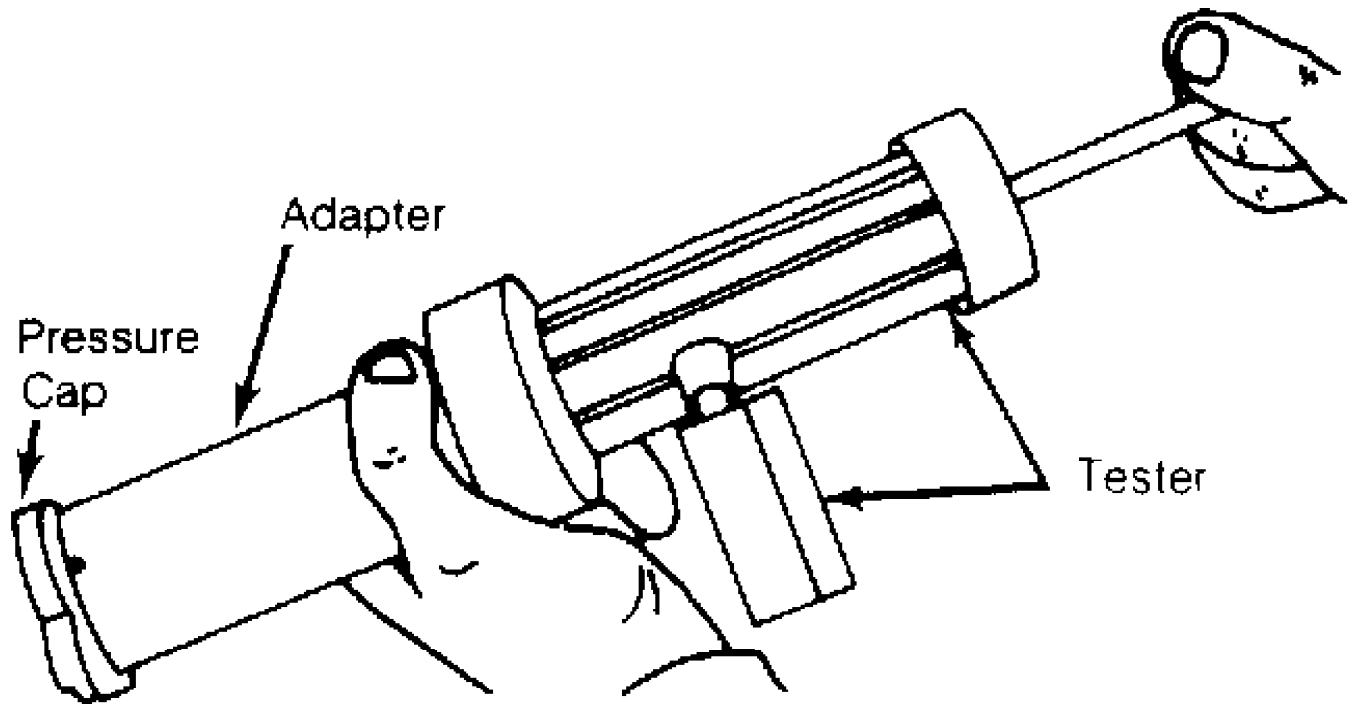


Fig. 2: Testing Radiator Pressure Cap

#### Cooling System

1) With engine off, wipe radiator filler neck seat clean. Fill radiator to correct level. Attach tester to radiator and pump until pressure is at upper level of radiator rating.

2) If pressure drops, inspect for external leaks. If no leaks are apparent, detach tester and run engine until normal operating temperature is reached. Reattach tester and observe. If pressure builds up immediately, a possible leak exists from a faulty head gasket or crack in head or block.

NOTE: Pressure may build up quickly. Release any excess pressure or cooling system damage may result.

3) If there is no immediate pressure build up, pump tester to within system pressure range (on radiator cap). Vibration of gauge pointer indicates compression or combustion leak into cooling system. Isolate leak by shorting each spark plug wire to cylinder block. Gauge pointer should stop or decrease vibration when leaking cylinder is shorted.



# H - TESTS W/O CODES

## 1993 Jeep Cherokee

1993 ENGINE PERFORMANCE  
Chrysler Corp. Trouble Shooting - No Codes

Jeep; Cherokee, Grand Wagoneer, Grand Cherokee, Wrangler

### INTRODUCTION

**CAUTION:** When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION Section before disconnecting battery.

Before diagnosing symptoms or intermittent faults, perform steps in appropriate F - BASIC TESTING and G - TESTS W/CODES articles. Use this article to diagnose driveability problems existing when a hard fault code is not present.

**NOTE:** Some driveability problems may have been corrected by manufacturer with a revised PCM. Check with manufacturer for latest PCM.

Symptom checks can direct the technician to malfunctioning component(s) for further diagnosis. A symptom should lead to a specific component, system test or an adjustment.

Use intermittent test procedures to locate driveability problems that do not occur when the vehicle is being tested. These test procedures should also be used if a soft (intermittent) trouble code was present, but no problem was found during self-diagnostic testing.

**NOTE:** For specific testing procedures, see appropriate I - SYS/COMP TESTS article. For specifications, see D - ADJUSTMENTS or C - SPECIFICATIONS article.

### SYMPTOMS

#### SYMPTOM DIAGNOSIS

Symptom checks cannot be used properly unless problem occurs while vehicle is being tested. To reduce diagnostic time, ensure steps in appropriate F - BASIC TESTING and G - TESTS W/CODES articles were performed before diagnosing a symptom. Following are some symptoms available for diagnosis.

- \* Engine Does Not Operate Smoothly Or Misfires At High Speed
- \* Engine Fails To Start, No Spark At Plugs
- \* Engine Backfires, Fails To Start
- \* Engine Continues To Run With Key Off
- \* Excessive Fuel Consumption
- \* Intermittent Spark

#### ENGINE DOES NOT OPERATE SMOOTHLY OR MISFIRES AT HIGH SPEED

- \* Ensure distributor cap is dry inside.
- \* Ensure distributor cap is not cracked or carbon-tracked.
- \* Check spark plugs.
- \* Check ignition system wires and connections.

- \* See appropriate F - BASIC TESTING article.

## ENGINE FAILS TO START, NO SPARK AT PLUGS

- \* Ensure distributor cap is not cracked or carbon-tracked.
- \* Check for defective rotor.
- \* Check for corroded wires and connections.
- \* See appropriate F - BASIC TESTING article.

## ENGINE BACKFIRES, FAILS TO START

- \* Ensure distributor cap is not cracked or carbon-tracked.
- \* Ensure ignition wires are connected in proper firing order.
- \* Check for moisture in distributor cap.
- \* See appropriate F - BASIC TESTING article.

## ENGINE CONTINUES TO RUN WITH KEY OFF

- \* Check for defective starter motor solenoid.
- \* Check for shorted diode in alternator warning light circuit.
- \* See appropriate I - SYS/COMP TESTS article.

## EXCESSIVE FUEL CONSUMPTION

- \* Check for vacuum leaks.
- \* Check air filter.
- \* See appropriate F - BASIC TESTING article.
- \* See appropriate I - SYS/COMP TESTS article.

## INTERMITTENT SPARK

- \* Check for loose or corroded distributor and coil terminals.
- \* See appropriate F - BASIC TESTING article.

## INTERMITTENTS

### INTERMITTENT PROBLEM DIAGNOSIS

Intermittent fault testing requires duplicating circuit or component failure to identify the problem. These procedures may lead to the computer setting a fault code which may help in diagnosis.

If problem vehicle does not produce fault codes, monitor voltage or resistance values using a DVOM, while attempting to reproduce conditions causing intermittent fault. A change in status on DVOM will indicate a fault has been located.

Use a DVOM to pinpoint faults. When monitoring voltage, ensure ignition switch is in ON position or engine is running. Ensure ignition switch is in OFF position or negative battery cable is disconnected when monitoring circuit resistance. Status changes on DVOM during test procedures will indicate area of fault.

### TEST PROCEDURES

#### Intermittent Simulation

To reproduce conditions creating an intermittent fault, use following methods:

- \* Lightly vibrate component.
- \* Heat component.
- \* Wiggle or bend wiring harness.
- \* Spray component with water mist.

\* Remove/apply vacuum source.

Monitor circuit/component voltage or resistance while simulating intermittent. If engine is running, monitor for self-diagnostic codes. Use test results to identify a faulty component or circuit.

# HEATER SYSTEM

1993 Jeep Cherokee

1993 AIR CONDITIONING & HEAT  
Chrysler Motors Corp. Heater Systems

Jeep; Cherokee & Wrangler

## DESCRIPTION

Cherokee and Wrangler use a blend-air heater system. Temperature of air entering passenger compartment is controlled by regulating amount of airflow through heater core and then blending it with a controlled amount of cool air that by-passes the heater core.

## OPERATION


### CHEROKEE

#### Mode Control Lever

The upper control lever on the control panel operates a vacuum switch on back of control panel. Vacuum switch controls vacuum to defroster, floor and panel vacuum motors, as well as a vacuum-actuated heater coolant control valve. See Figs. 1 and 4. The heater coolant control valve closes when vacuum is applied to it.

#### Temperature Control Lever

The lower control lever on the control panel moves a cable that controls the position of the blend-air door in the heater case.

Mode Lever Position	Air Discharge	Blower Speeds	Panel Door	Floor Door	Defrost Door	Water Valve
Off	Closed	None	Closed	Closed	Closed	Closed
Vent	Panel Registers	4	Open	Closed	Closed	Closed
Bi-Level	Panel Registers and Floor With Def. Bleed	4	Open	Open	Bleed	Open (1)
Heat	Floor With Def. Bleed	4	Closed	Open	Bleed	Open (1)
	Defroster	4	Closed	Closed	Open	Open (1)

(1) HEATER CONTROL VALVE CLOSSES IN FULL COOL TEMPERATURE LEVER POSITION

Fig. 1: Heater System Operation (Cherokee)  
Courtesy of Chrysler Corp.

### WRANGLER

NOTE: System does not use a heater coolant control valve. Coolant always flows through the heater core.

#### Mode Control Lever

The upper lever on the control panel moves 2 cables, one for the vent doors and one for the defrost/floor duct door. See Figs. 2 and 3. Lever also operates vacuum switch on back of control panel. The

vacuum switch allows or denies vacuum to the fresh air door vacuum motor.

#### Temperature Control Lever

The lower lever on the control panel moves a cable that controls the position of the blend-air door in the heater case.

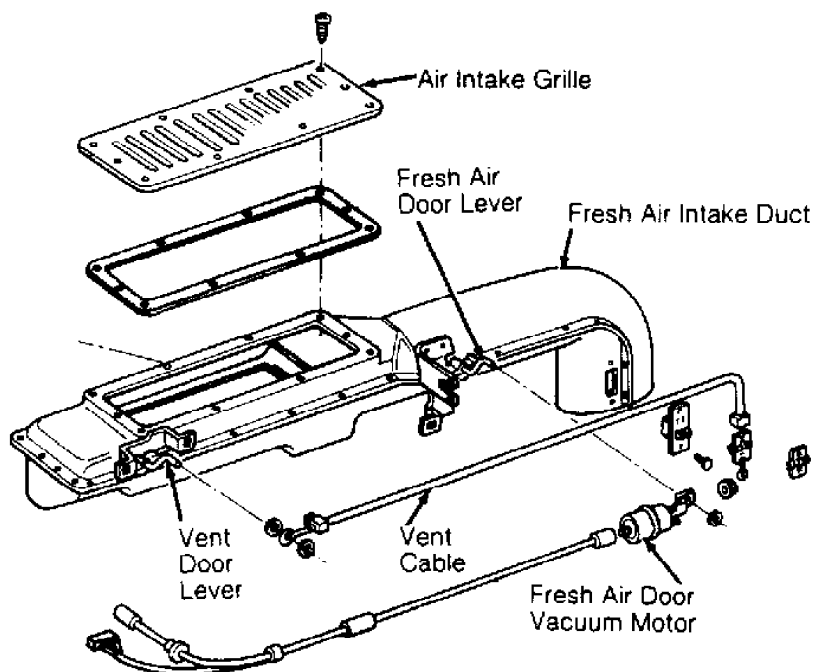
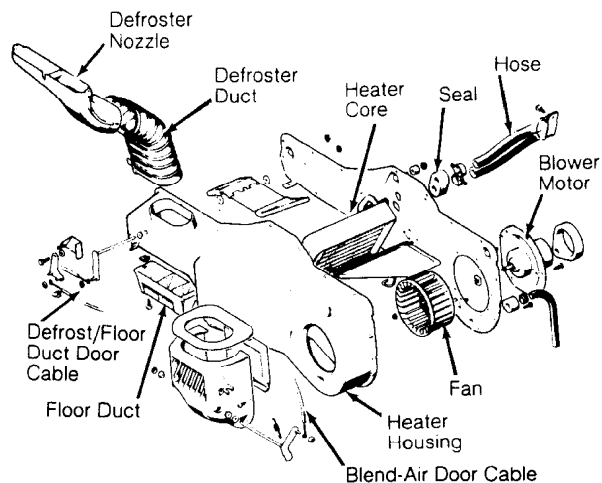


Fig. 2: Exploded View Of Air Intake System (Wrangler)  
Courtesy of Chrysler Corp.



17581  
Fig. 3: Exploded View Of Heater Case (Wrangler)  
Courtesy of Chrysler Corp.

## ADJUSTMENTS

## **CONTROL CABLES**

### **Cherokee**

Temperature control cable is attached to blend-air door lever by a retaining clip and a self-adjusting clip. When connecting cable to door lever, self-adjusting clip will adjust cable when it is snapped into position on lever.

### **Wrangler**

1) Since left cable operates right cable, install and adjust cables in correct sequence. This maintains self-adjusting mechanism.

2) Connect cables to control panel. Connect only right vent door cable to vent door. Open and close right vent door one time by sliding control panel lever. Connect left cable, and ensure both vent doors open at same time.

## **TROUBLE SHOOTING**

### **BLOWER DOES NOT RUN**

Blown fuse. Loose connection or poor ground. Faulty switch, motor or resistor.

### **BLOWER RUNS AT ONE SPEED**

Faulty switch or resistor.

### **BLOWER RUNS, BUT NO AIR CIRCULATION**

Air inlet blocked. Fan not attached to motor shaft. Inoperative air inlet door.

### **HEAT OUTPUT WHEN CONTROLS ARE OFF**

Blend-air door cable misadjusted. Blend-air door binding in housing.

### **LITTLE OR NO AIR FROM DEFROSTER OUTLETS**

Defroster duct misaligned. Defroster cable incorrectly adjusted. Leaking air duct seals. Defroster duct damaged.

### **LITTLE OR NO AIR FROM FLOOR OUTLETS**

Misadjusted heater air door cable. Obstructed heater housing or ducts. Clogged heater core fins. Leaking air duct seals.

### **NOT ENOUGH HEAT**

Low coolant or plugged heater core. Incorrect thermostat. Incorrect adjustment of cables. Heater system air leaks. Blend-air door not in proper position.

## **REMOVAL & INSTALLATION**

### **BLOWER MOTOR**

Removal & Installation (Cherokee - 2.5L Engine)

Disconnect blower motor connector in engine compartment, near

blower motor. Remove blower motor screws. Remove blower motor. To install, reverse removal procedure.

#### Removal & Installation (Cherokee - 4.0L Engine)

1) Remove coolant bottle retaining strap. Move bottle aside. Remove coolant bottle bracket. Remove anti-lock brake pump and bracket as an assembly (if equipped). Move assembly aside.

2) Disconnect blower motor connector in engine compartment, near blower motor. Remove blower motor screws. Remove blower motor. To install, reverse removal procedure.

#### Removal & Installation (Wrangler)

Remove heater housing. See HEATER HOUSING. Remove blower motor screws and blower motor. To install, reverse removal procedure.

### CONTROL CABLES

#### Removal (Cherokee)

Remove control panel. See CONTROL PANEL. Disconnect cable wire from blend-air door lever. Squeeze cable housing tabs together using needle-nose pliers to detach cable housing from slot in case. DO NOT break cable housing. Remove cable.

#### Installation

Connect cable wire to blend-air door lever. Snap cable housing tabs into slot in case. Route cable to control panel. Connect cable wire to control panel. Install control panel.

#### Removal & Installation (Wrangler)

Disconnect cables from vent doors. Disconnect cables from control panel levers. Remove cables by squeezing tabs using needle-nose pliers. Remove cable. Connect and adjust cables. See ADJUSTMENTS.

### CONTROL PANEL

#### Removal & Installation

1) Disconnect negative battery cable. Remove 6 screws from instrument panel bezel. Remove bezel (on Cherokee, bezel is snap-fitted to instrument panel). Remove radio (if equipped).

2) Remove control panel screws. Pull out control panel and disconnect vacuum hoses, wires and cables. Note locations for installation reference. Remove control panel. To install, reverse removal procedure.

### HEATER CORE

#### Removal & Installation (Cherokee)

1) Drain cooling system. Disconnect heater hoses from heater core tubes. Remove blower housing. Remove heater core screws. Pull heater core out of housing.

2) To install, cement heater core seal in place to prevent it from moving during installation. Insert heater core into housing. To install remaining components, reverse removal procedure.

#### Removal & Installation (Wrangler)

Remove heater housing. See HEATER HOUSING. Remove cover from housing. Remove heater core from housing. To install, reverse removal procedure.

### HEATER HOUSING

#### Removal & Installation (Cherokee)

- 1) Disconnect negative battery cable. Drain cooling system. Disconnect blower motor connector in engine compartment, near blower motor. Remove console (if equipped). Remove lower instrument panel.
- 2) Disconnect blower motor resistor connector. Disconnect vacuum hose from vacuum motor. Cut plastic strap holding blower housing to heater housing.
- 3) Disconnect control cable from blend-air door lever. Remove control cable. Remove clip from rear of blower housing flange, and remove housing screws. Remove right kick panel.
- 4) Remove instrument panel support bolt. To disengage blower housing studs from firewall, gently pull out right side of instrument panel and then rotate blower housing downward and rearward. Remove blower housing.
- 5) Remove heater core screws. Remove heater core. Remove defroster duct. Disconnect vacuum hoses from vacuum motors. Remove heater housing nuts from engine compartment firewall. Remove heater housing.
- 6) To install, reverse removal procedure. Before installing heater core, cement core seal to core to keep it in place during installation. After installation, fill cooling system.

#### Removal & Installation (Wrangler)

- 1) Disconnect negative battery cable. Drain about 2 quarts of coolant from radiator. Disconnect heater hoses from core tubes. Disconnect vent door cables. Disconnect blower motor connector in engine compartment, near blower motor. Disconnect defroster duct.
- 2) Remove heater housing nuts from studs on engine compartment firewall. Tilt heater housing downward to disengage it from defroster duct. Pull heater housing rearward and out from under instrument panel. To install, reverse removal procedure.

### VACUUM DIAGRAM

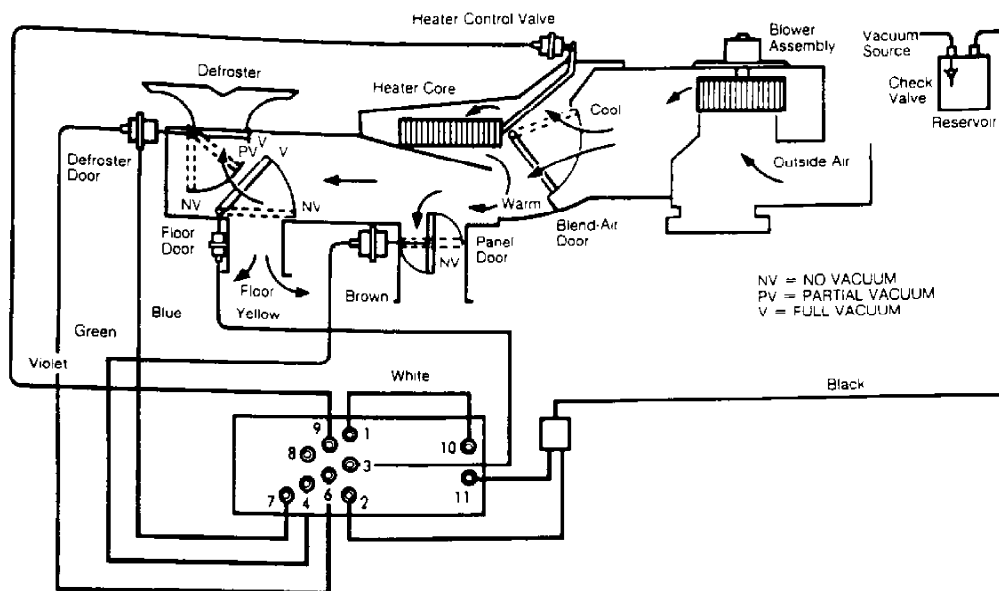
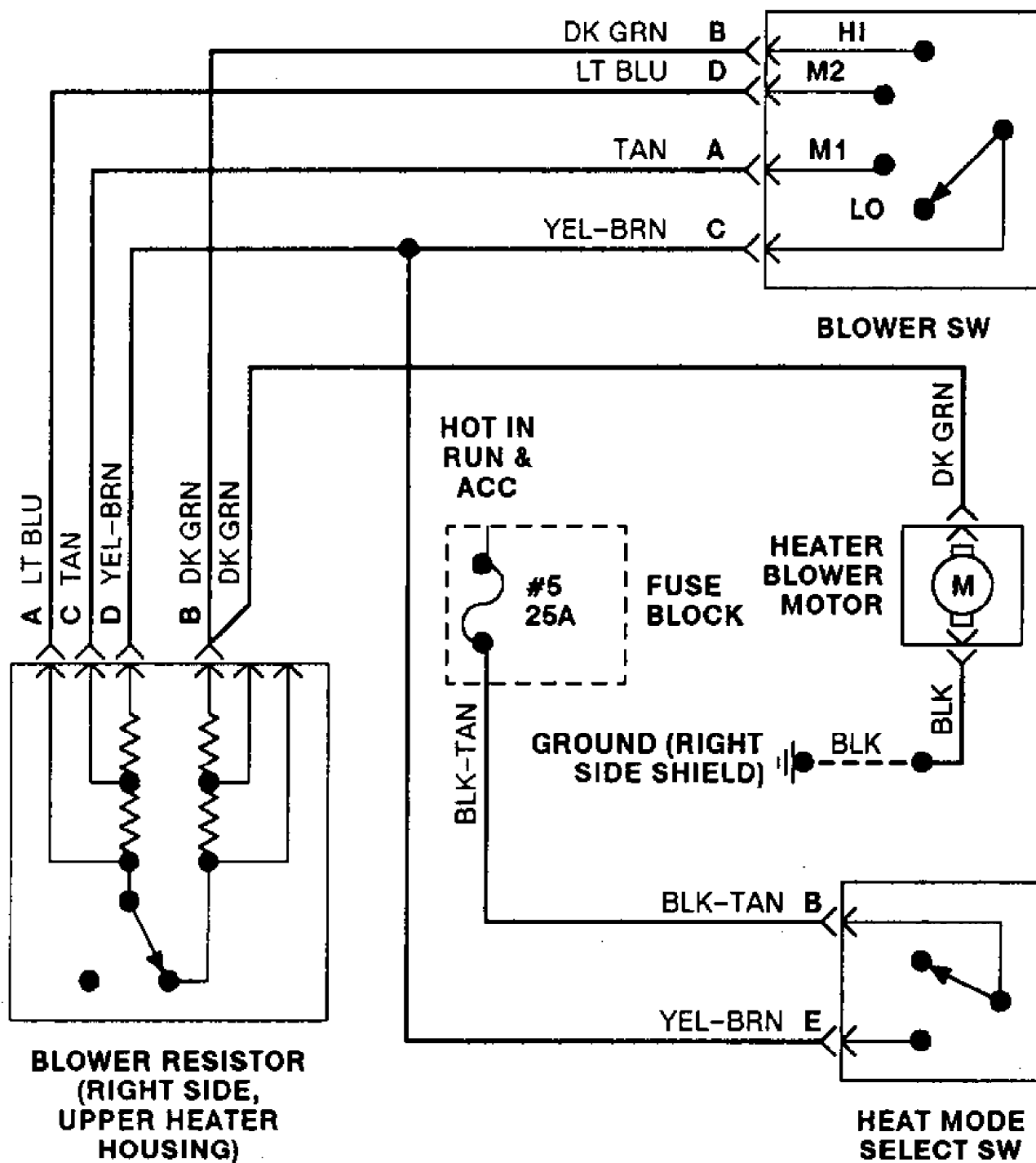


Fig. 4: Heater Control System Vacuum Diagram (Cherokee)  
Courtesy of Chrysler Corp.

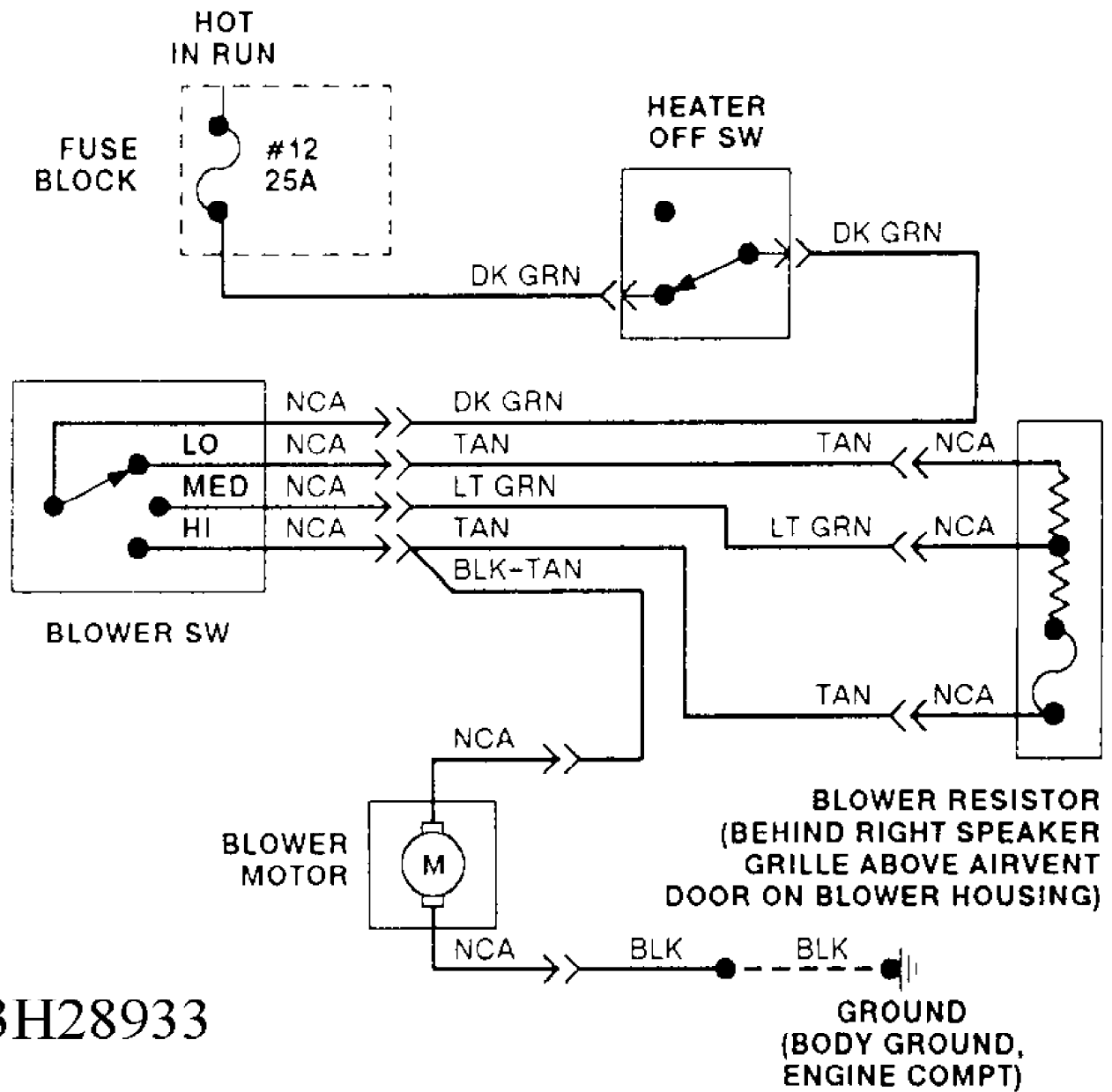
### WIRING DIAGRAMS





93G28932

Fig. 5: Heater System Wiring Diagram (Cherokee)



93H28933

Fig. 6: Heater System Wiring Diagram (Wrangler)

# HOW TO USE SYSTEM WIRING DIAGRAMS

1993 Jeep Cherokee

GENERAL INFORMATION  
Using Wiring Diagrams

All Models

## INTRODUCTION

This cd obtains wiring diagrams and technical service bulletins, containing wiring diagram changes from the domestic and import manufacturers. These are checked for accuracy and are all redrawn into a consistent format for easy use.

In the past, when cars were simpler, diagrams were simpler. All components were connected by wires and diagrams seldom exceeded 4 pages in length. Today, some wiring diagrams require more than 16 pages. It would be impractical to expect a service technician to trace a wire from page 1 across every page to page 16.

Removing some of the wiring maze reduces eyestrain and time wasted searching across several pages. Today the majority of these diagrams follow a much improved format, which permits space for internal switch details.

Wiring diagrams are drawn in a "top-down" format. The diagrams are drawn with the power source at the top of the diagram and the ground point at the bottom of the diagram. Components locations are identified on the wiring diagrams. Any wires that don't connect directly to a component are identified on the diagram to indicate where they go.

## COLOR ABBREVIATIONS

COLOR ABBREVIATIONS TABLE

Color	Normal	Optional
Black .....	BLK .....	BK
Blue .....	BLU .....	BU
Brown .....	BRN .....	BN
Clear .....	CLR .....	CR
Dark Blue .....	DK BLU .....	DK BU
Dark Green .....	DK GRN .....	DK GN
Green .....	GRN .....	GN
Gray .....	GRY .....	GY
Light Blue .....	LT BLU .....	LT BU
Light Green .....	LT GRN .....	LT GN
Orange .....	ORG .....	OG
Pink .....	PNK .....	PK
Purple .....	PPL .....	PL
Red .....	RED .....	RD
Tan .....	TAN .....	TN
Violet .....	VIO .....	VI
White .....	WHT .....	WT
Yellow .....	YEL .....	YL

## IDENTIFYING WIRING DIAGRAM ABBREVIATIONS

NOTE: Abbreviations used on these diagrams are normally self-explanatory. If necessary see ABBREVIATIONS

article in GENERAL INFORMATION.

IDENTIFYING WIRING DIAGRAM SYMBOLS

NOTE: Standard wiring symbol are used in these diagrams. The illustration below will help clarify any symbols that are not easily understood at a glance. Most components are labeled "Motor", "Switch" or "Relay" in addition to being drawn with the standard symbol.

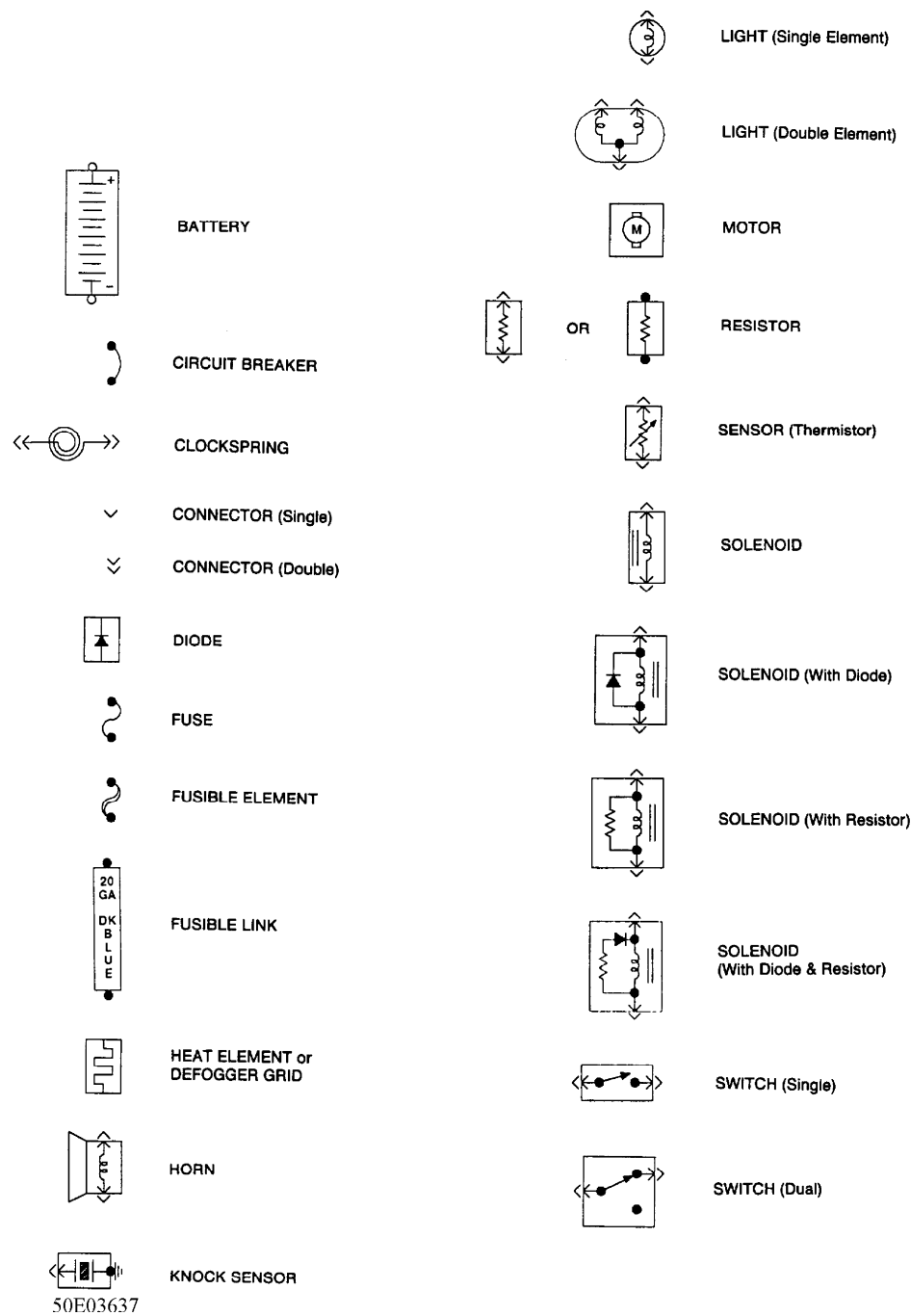


Fig. 1: Identifying Wiring Diagram Symbols

## WIRING DIAGRAM COMPONENT LOCATIONS

When trying to locate a component in a wiring diagram and you don't know the specific system where it is located, use this handy component locator to find the system wiring diagram in which the component is located. Then, go to that system and locate the component within the wiring diagram.

For example, if you don't know the specific system in which the ignition switch is located, look up ignition switch in the wiring diagram component location tables and go to the appropriate wiring diagram(s) which contain either full or partial views of the ignition switch. The full view of the ignition switch is located in Power Distribution.

The first listing for the component will be the full or most complete view of the component. Additional listings will be partial views of the component. Not all components are used on all models.

All components will have a partial view in Ground Distribution and Power Distribution. Data Link Connectors show connecting circuits between modules. Alternate names for components may be listed in wiring diagram component locations tables.

WIRING DIAGRAM COMPONENT LOCATIONS TABLE

Component	Wiring Diagram
ABS Electronic Control Unit .....	Anti-Lock Brakes Data Link Connectors
ABS Hydraulic Unit .....	Anti-Lock Brakes
Acceleration Sensor .....	Anti-Lock Brakes
Accessory Delay Relay .....	Power Windows
A/C Compressor Clutch Relay .....	Engine Performance
A/C Sensor .....	Engine Performance
A/C Pressure Switch .....	Engine Performance
Adaptive Lamp Control Module .....	Exterior Lights
Air Bag(s) .....	Air Bag Restraint System
Air Bag Module .....	Air Bag Restraint System
Air Bag Sensor(s) .....	Air Bag Restraint System
Air Injection Pump Relay .....	Engine Performance
Air Temperature Sensor .....	Overhead Console
Alternator (Generator) .....	Generators & Regulators
Anti-Theft Control Module .....	Anti-Theft System Starters
Autolamp Control Relay .....	Headlight Systems Daytime Running Lights
Automatic Shutdown (ASD) Relay .....	Engine Performance Generators & Regulators
Autostick Switch .....	Engine Performance
Auxiliary Battery Relay .....	Generators & Regulators
Back-Up Lights .....	Back-Up Lights Exterior Lights
Barometric (BARO) Pressure Sensor .....	Engine Performance
Battery .....	Power Distribution
Battery Temperature Sensor .....	Engine Performance
Body Control Module .....	Body Control Computer Anti-Theft System Daytime Running Lights Engine Performance Headlight Systems Warning Systems
Boost Control Solenoid .....	Engine Performance
Boost Sensor .....	Engine Performance
Brake Fluid Level Switch .....	Analog Instrument Panels

Brake On/Off (BOO) Switch .....	Cruise Control Systems
	Engine Performance
	Shift Interlock Systems
Buzzer Module .....	Warning Systems
Camshaft Position (CMP) Sensor .....	Engine Performance
Central Control Module .....	Anti-Theft System
Clockspring .....	Air Bag Restraint System
	Cruise Control Systems
	Steering Column Switches
Clutch Pedal Position Switch .....	Starters
Clutch Start Switch .....	Starters
Combination Meter .....	Analog Instrument Panels
Constant Control Relay Module (CCRM) .....	Engine Performance
	Electric Cooling Fans
Convenience Center .....	Power Distribution
	Illumination/Interior Lights
Convertible Top Motor .....	Power Convertible Top
Convertible Top Switch .....	Power Convertible Top
Crankshaft Position (CKP) Sensor .....	Engine Performance
Cruise Control Module .....	Cruise Control Systems
Cruise Control Switch .....	Cruise Control Systems
Condenser Fan Relay(s) .....	Electric Cooling Fans
Data Link Connector (DLC) .....	Engine Performance
Daytime Running Lights Module .....	Daytime Running Lights
	Exterior Lights
Defogger Relay .....	Rear Window Defogger
Diagnostic Energy Reserve Module (DERM) ...	Air Bag Restraint System
Discriminating Sensor (Air Bag) .....	Air Bag Restraint System
Distributor .....	Engine Performance
Door Lock Actuators .....	Power Door Locks
	Remote Keyless Entry
Door Lock Relay(s) .....	Power Door Locks
Electrochromic Mirror .....	Power Mirrors
Electronic Level Control (ELC)	
Height Sensor .....	Electronic Suspension
Electronic Level Control (ELC) Module .....	Electronic Suspension
Engine Coolant Temperature (ECT)	
Sending Unit .....	Analog Instrument Panels
Engine Coolant Temperature (ECT) Sensor .....	Engine Performance
Engine Control Module .....	Engine Performance
	Generators & Regulators
	Starters
ETACS ECU .....	Warning Systems
	Power Windows
	Remote Keyless Entry
Evaporative (EVAP) Emissions Canister .....	Engine Performance
EVAP Canister Purge Solenoid .....	Engine Performance
EVAP Canister Vent Solenoid .....	Engine Performance
Exhaust Gas Recirculation (EGR) Valve .....	Engine Performance
Fuel Tank Vacuum Sensor .....	Engine Performance
Fog Lights .....	Headlight Systems
	Daytime Running Lights
Fog Light Relay .....	Headlight Systems
	Daytime Running Lights
Fuel Door Release Solenoid .....	Power Fuel Door Release
Fuel Gauge Sending Unit .....	Analog Instrument Panels
Fuel Injectors .....	Engine Performance
Fuel Pump .....	Engine Performance
Fuel Pump Relay .....	Engine Performance
	Power Distribution
Fuse/Relay Block .....	Power Distribution
Fusible Links .....	Power Distribution
	Generators & Regulators

	Starters
Generator .....	Generators & Regulators
	Engine Performance
	Power Distribution
Generic Electronic Module (GEM) .....	Body Control Modules
	Electronic Suspension
Glow Plug Relay .....	Engine Performance
Glow Plugs .....	Engine Performance
Grounds .....	Ground Distribution
Headlight Door Module .....	Headlight Doors
Headlight Relay .....	Headlight Systems
	Daytime Running Lights
Headlights .....	Headlight Systems
	Daytime Running Lights
Heated Oxygen Sensor(s) (HO2S) .....	Engine Performance
Heated Windshield Control Module .....	Heated Windshields
Height Sensor .....	Electronic Suspension
Horns .....	Steering Column Switches
Horn Relay .....	Steering Column Switches
Idle Air Control (IAC) Motor/Valve .....	Engine Performance
Ignition Coil(s) .....	Engine Performance
Ignition Key Lock Cylinder .....	Anti-Theft System
Ignition Module .....	Engine Performance
Ignition Switch .....	Power Distribution
	Engine Performance
	Generators & Regulators
	Starters
Illuminated Entry Module .....	Illumination/Interior Lights
Illumination Lights .....	Illumination/Interior Lights
Impact Sensor .....	Air Bag Restraint System
Inertia Fuel Shutoff Switch .....	Engine Performance
Inhibit Relay .....	Starters
Instrument Cluster .....	Analog Instrument Panels
Intake Air Temperature (IAT) Sensor .....	Engine Performance
Interior Lights .....	Illumination/Interior Lights
Interlock Switch .....	Starters
Junction Block .....	Power Distribution
Keyless Entry Receiver .....	Remote Keyless Entry
Key Reminder Switch .....	Starters
Knock Sensor .....	Engine Performance
Lamp Control Module .....	Exterior Lights
License Plate Lamp .....	Exterior Lights
Lighting Control Module .....	Lighting Control Modules
	Anti-Theft System
	Daytime Running Lights
	Headlight Systems
Lower Relay .....	Power Convertible Top
Malfunction Indicator Light (MIL) .....	Engine Performance
	Instrument Panels
Manifold Absolute Pressure (MAP) Sensor .....	Engine Performance
Mass Airflow (MAF) Sensor .....	Engine Performance
Mega Fuse .....	Generators & Regulators
Memory Seat/Mirror Module .....	Memory Systems
Mirror Defogger .....	Rear Window Defogger
Moon Roof Motor .....	Power Moon Roof
Moon Roof Relay .....	Power Moon Roof
Multi-Function Control Module .....	Warning Systems
Neutral Safety Switch .....	Starters
Oil Level Switch .....	Engine Performance
Oil Pressure Switch/Sending Unit .....	Analog Instrument Panels
	Engine Performance
Overhead Console .....	Overhead Console
Oxygen Sensor(s) (O2S) .....	Engine Performance

Parking Brake Switch .....	Analog Instrument Panels
Park Lights .....	Exterior Lights
Park/Neutral Position Switch .....	Starters
	Engine Performance
	Anti-Theft System
	Body Control Module
Perimeter Lighting Control Relay .....	Exterior Lights
Power Amplifier .....	Power Antennas
Power Antenna Module .....	Power Antennas
Power Antenna Motor .....	Power Antennas
Power Distribution Center .....	Power Distribution
	Generators & Regulators
	Starters
Power Door Lock Motors .....	Power Door Locks
Power Mirror Motors .....	Power Mirrors
	Memory Systems
Power Sliding Door Controller .....	Power Sliding Side Door
Power Seat Motors .....	Power Seats
	Memory Systems
Power Steering Pressure Switch .....	Engine Performance
Power Top Motor .....	Power Convertible Top
Power Top Relay(s) .....	Power Convertible Top
Powertrain Control Module .....	Engine Performance
	Analog Instrument Panels
	Cruise Control Systems
	Data Link Connectors
	Generators & Regulators
	Starters
Power Window Motors .....	Power Windows
Power Window Relay(s) .....	Power Windows
Radiator Fan Motor(s) .....	Electric Cooling Fans
Radiator Fan Relay(s) .....	Engine Performance
	Electric Cooling Fans
Rainsense Module .....	Wiper/Washer Systems
Raise Relay .....	Power Convertible Top
Remote Anti-Theft Personality (RAP) Module .....	Anti-Theft System
	Starters
	Warning Systems
Seat Belt Pretensioners .....	Air Bag Restraint System
Seat Belt Retractor Solenoid .....	Passive Restraints
Seat Belt Switch .....	Air Bag Restraint System
	Passive Restraints
Shift Interlock Solenoid .....	Shift Interlock Systems
Shift Lock Actuator .....	Shift Interlock Systems
Side Marker Lights .....	Exterior Lights
SIR Coil Assembly (Clockspring) .....	Air Bag Restraint System
Slip Ring (Clockspring) .....	Air Bag Restraint System
	Steering Column Switches
SRS Control Module .....	Air Bag Restraint System
Starter Motor .....	Starters
Starter Interrupt Relay .....	Starters
Starter Solenoid .....	Starters
Starter Relay .....	Starters
Steering Wheel Position Sensor .....	Anti-Lock Brakes
Stoplights .....	Exterior Lights
Stoplight Switch .....	Engine Performance
	Cruise Control Systems
	Anti-Lock Brakes
Sun Roof ECU .....	Power Sun Roof
Sun Roof Motor .....	Power Sun Roof
Sun Roof Position Sensor .....	Power Sun Roof
Taillights .....	Exterior Lights
Throttle Position (TP) Sensor .....	Engine Performance



Torque Converter Clutch Solenoid/Switch .....	Engine Performance
Traction Control Switch .....	Anti-Lock Brakes
Trailer Tow Connector .....	Exterior Lights
Trailer Tow Relay .....	Exterior Lights
Transmission/Transaxle .....	Engine Performance
Transmission Control Module (TCM) .....	Engine Performance
	Starters
Transmission Range Sensor .....	Starters
	Back-Up Lights
	Engine Performance
Transmission Range Switch .....	Back-Up Lights
	Engine Performance
	Anti-Theft System
Turn Signal Flasher .....	Exterior Lights
Turn Signal Lights .....	Exterior Lights
Twilight Sentinel Switch .....	Headlight Systems
	Daytime Running Lights
Vapor Canister Leak Detection Pump .....	Engine Performance
Vehicle Control Module (VCM) .....	Engine Performance
Vehicle Dynamic Module .....	Electronic Suspension
Vehicle Speed Control Servo .....	Cruise Control Systems
Vehicle Speed Sensor .....	Data Link Connectors
	Analog Instrument Panels
	Cruise Control Systems
	Electronic Suspension
Voltage Regulator .....	Generators & Regulators
Water-In-Fuel Sensor .....	Engine Performance
	Analog Instrument Panels
Wheel Speed Sensors .....	Anti-Lock Brakes
Window Timer Module .....	Power Convertible Top
Windshield Intermittent Wiper Relay .....	Wiper/Washer Systems
Windshield Washer Motor .....	Wiper/Washer Systems
Wiper Motor .....	Wiper/Washer Systems

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# **I - SYSTEM/COMPONENT TESTS - 2.5L & 4.0L**

## **1993 Jeep Cherokee**

1993 ENGINE PERFORMANCE

Chrysler Corp. 2.5L & 4.0L System & Component Testing

Jeep; Cherokee, Grand Cherokee, Wrangler

### **INTRODUCTION**

NOTE: For Grand Cherokee with 5.2L engine, see I - 5.2L SYS/COMP TESTS article in this section.

Before testing separate components or systems, perform procedures in F - 2.5L & 4.0L BASIC TESTING article in this section. Since many computer-controlled and monitored components set a trouble code if they malfunction, also perform procedures in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

NOTE: Testing individual components does not isolate possible short or open circuits. Unless stated otherwise in test procedure, perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) having a minimum 10-megohm input impedance. Use ohmmeter to isolate wiring harness short or open circuits.

### **COMPUTERIZED ENGINE CONTROLS**

#### **POWERTRAIN CONTROL MODULE (PCM)**

Power & Ground Circuits

Check power and ground circuits using a DVOM and appropriate wiring diagram in L - WIRING DIAGRAMS article in this section.

### **ENGINE SENSORS & SWITCHES**

Camshaft Position Sensor

1) Use an analog voltmeter. DO NOT remove distributor connector from distributor. Insert voltmeter leads into backside of distributor wiring harness connector to make contact with terminals. Ensure connector is not damaged when inserting test probes.

2) Insert positive voltmeter lead into camshaft position sensor signal output circuit (Tan/Yellow wire on Cherokee and Wrangler; Gray/Black wire on Grand Cherokee) at distributor wiring harness connector. Insert negative voltmeter lead into ground circuit (Black/Light Blue wire) at distributor wiring harness connector. Set voltmeter to 15-volt DC scale.

3) With distributor cap removed, manually rotate engine until pulse ring enters sync signal generator on camshaft position sensor. Distributor rotor should be at 9 o'clock position. Turn ignition switch to ON position. With pulse ring positioned in the sync signal generator, reading should be approximately 5 volts.

4) If no voltage is present, check voltmeter leads for good connections. If connections are okay and there is still no voltage, check for voltage at supply circuit (Orange wire on Cherokee and Wrangler; White/Black wire on Grand Cherokee).

5) If no voltage is present at supply wire, remove PCM connector. Check voltage at PCM pin No. 7 and ground with wiring harness connected. PCM is located on left side of engine compartment. If there is no voltage at PCM, see appropriate camshaft position sensor circuit tests in G - 2.5L & 4.0L TESTS W/ CODES article in this

section.

6) If voltage is present at supply wire, replace camshaft position sensor. If voltage is present at PCM pin No. 7, but not at supply wire, check continuity of supply wire between the distributor connector and the PCM. If no continuity exists, repair wiring harness as necessary.

7) If supply wire is okay, check continuity between camshaft position sensor signal output wire at the distributor connector and PCM pin No. 44. If no continuity exists, repair wiring harness as necessary.

8) If camshaft position sensor signal output wire is okay, check continuity between ground circuit wire at the distributor connector and ground. If no continuity exists, repair wiring harness as necessary. If ground wire is okay, go to next step.

9) While observing voltmeter, crank engine. Voltmeter needle should fluctuate from 0-5 volts while the engine is cranking. This verifies that camshaft position sensor in distributor is operating properly and that a sync pulse signal is being generated. If voltmeter does not fluctuate, replace camshaft position sensor.

Charge Air Temperature Sensor (Grand Cherokee)  
See MANIFOLD AIR TEMPERATURE (MAT) SENSOR below.

#### Coolant Temperature Sensor

1) Disconnect coolant temperature sensor. Using a DVOM, check sensor resistance. Resistance should be as specified in the COOLANT TEMP SENSOR & MANIFOLD AIR TEMP SENSOR RESISTANCE table. Replace sensor if necessary.

2) Check continuity between PCM wiring harness terminal No. 2 and sensor connector terminal. Also check continuity between PCM wiring harness terminal No. 4 and sensor connector terminal. Repair wiring if an open circuit is indicated.

NOTE: Also see appropriate coolant temperature sensor tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

COOLANT TEMP SENSOR & MANIFOLD AIR TEMP SENSOR RESISTANCE TABLE

Temperature °F (°C)	Minimum Ohms	Maximum Ohms
-40 (-40)	291,490	381,710
-4 (-20)	85,850	108,390
14 (-10)	49,250	61,430
32 (0)	29,330	35,990
50 (10)	17,990	21,810
68 (20)	11,370	13,610
77 (25)	9120	10,880
86 (30)	7370	8750
104 (40)	4900	5750
122 (50)	3330	3880
140 (60)	2310	2670
158 (70)	1630	1870
176 (80)	1170	1340
194 (90)	860	970
212 (100)	640	720
230 (110)	480	540
248 (120)	370	410

#### Crankshaft Position Sensor

1) Disconnect crankshaft position sensor. Connect ohmmeter across sensor terminal No. 2 (Black/Light Blue wire) and terminal No. 1 (Gray/Black wire on Cherokee and Wrangler; Red/Light Green wire on

Grand Cherokee).

2) Ohmmeter should indicate an open circuit. Replace sensor if reading is not as specified. Also see appropriate crankshaft position sensor tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

#### Manifold Absolute Pressure (MAP) Sensor

1) Inspect MAP sensor vacuum hose connections at throttle body and sensor. Replace or repair vacuum hose if necessary.

2) Turn ignition on with engine off. Using DVOM, check MAP sensor output voltage. Connect DVOM to MAP sensor terminal "B" (Dark Green/Red wire on Cherokee and Wrangler; Red/White wire on Grand Cherokee) and ground. Terminal identification letters are marked on sensor body.

3) Output voltage should be 4-5 volts. Voltage should drop to 1.5-2.1 volts with a hot engine operating in Neutral and at idle speed. Also check for output voltage at PCM wiring harness terminal No. 1 on Cherokee and Wrangler or terminal No. 5 on Grand Cherokee. If voltage is not as previously specified, repair wiring harness as necessary.

4) With ignition on, check MAP sensor supply voltage at sensor connector terminal "C" (Violet/White wire). Supply voltage should be 4.5-5.5 volts. Also check for supply voltage at PCM wiring harness terminal No. 6. If supply voltage is not as specified, repair wiring harness if necessary.

5) Check continuity of MAP sensor ground circuit at sensor connector terminal "A" (Black/Light Blue wire) and PCM wiring harness terminal No. 4. Check continuity of MAP sensor ground circuit at sensor connector terminal No. 1 (Black/Light Blue wire) and PCM wiring harness terminal No. 4. Repair wiring harness if necessary.

6) Check continuity of MAP sensor ground circuit between PCM wiring harness terminals No. 4 and 11. If ohmmeter indicates an open circuit, go to next step. If ground connection is okay, replace PCM.

NOTE: If terminal No. 4 has a short circuit to 12 volts, correct this condition before replacing PCM. If necessary, perform appropriate MAP sensor tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

7) Check for defective sensor ground connection. Connection is located on right side of engine block, at oil dipstick tube mounting block. Repair connection as necessary.

#### Manifold Air Temperature (MAT) Sensor

1) Disconnect manifold air temperature sensor. Using DVOM, check sensor resistance. Resistance should be as specified in the COOLANT TEMP SENSOR & MANIFOLD AIR TEMP SENSOR RESISTANCE table. If resistance is not as specified, replace sensor.

2) Check resistance between PCM wiring harness terminal No. 21 and sensor connector terminal. Also check resistance between PCM wiring harness terminal No. 4 and sensor connector terminal. Repair wiring if resistance is greater than one ohm.

#### Oxygen (O2) Sensor (Heating Element)

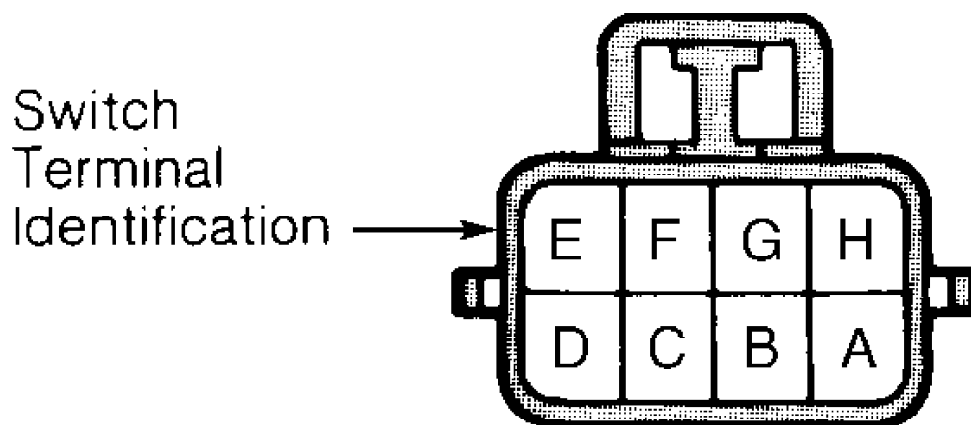
Disconnect oxygen sensor connector. Using an ohmmeter, check sensor heating element resistance. On Cherokee, connect ohmmeter to Black/Tan and Dark Green/Black sensor wires. On Wrangler, connect ohmmeter to Black and Dark Green/Orange sensor wires. On Grand Cherokee, connect ohmmeter to Black/Tan and Orange/Dark Blue sensor wires. Heating element resistance should be 5-7 ohms. Replace oxygen sensor if ohmmeter reads infinity.

#### Park/Neutral Switch (AW-4 Auto. Trans.)

1) Disconnect park/neutral switch. Ensure continuity exists between terminals "B" and "C" with transmission in Park or Neutral. See Fig. 1.

2) Ensure continuity exists between terminals "A" and "E" with transmission in Reverse. See Fig. 1. Ensure continuity exists between terminals "A" and "G" with transmission in 3rd gear.

3) Ensure continuity exists between terminals "A" and "H" with transmission in 1st or 2nd gear. See Fig. 1. If switch continuity tests are okay, check gearshift adjustment or back-up light circuit. If switch fails any continuity test, replace park/neutral switch.



	B	C	A	E	G	H
P						
R						
N						
D						
3						
1-2						

91C13971

Fig. 1: Testing Park/Neutral Switch Continuity (AW-4 Auto. Trans.)  
Courtesy of Chrysler Corp.

NOTE: Also see appropriate park/neutral switch input test procedures in G - 2.5L & 4.0L TESTS W/ CODES article in

this section.

#### Park/Neutral Switch (32RH Auto. Trans.)

1) Disconnect park/neutral switch. Check continuity between switch center terminal and transmission case. Continuity should exist only when transmission is in Park or Neutral.

2) Shift transmission into Reverse. Check continuity between the 2 outside terminals on switch. Continuity should exist only when transmission is in Reverse. Check continuity between each outer terminal and transmission case.

3) Continuity should not exist between either terminal and case while in Reverse. If switch continuity tests are okay, check gearshift adjustment or back-up light circuit. If switch fails any continuity test, replace park/neutral switch.

#### Throttle Position Sensor (TPS)

1) Turn ignition on. Check TPS output voltage at sensor wiring harness center terminal. At idle, output voltage should be greater than .2 volt.

2) Gradually open throttle plate. Output voltage should gradually increase as throttle plate is opened. At wide open throttle, output voltage must be less than 4.8 volts.

NOTE: Also see appropriate throttle position sensor tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

#### Vehicle Speed Sensor

See appropriate vehicle speed sensor tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

## MODULES, MOTORS & RELAYS

### MODULES

#### Theft Alarm Module (Cherokee & Grand Cherokee)

1) Turn ignition switch to ACC position 3 times and leave in ACC position to activate Security Alarm Module (SAM) self-diagnostics. If headlights do not flash, go to step 3).

2) If horn does not sound twice, go to step 9). If exterior lights do not flash, go to step 10). If parking lights and taillights do not flash, go to step 11). If horn sounds twice and headlights, parking lights and taillights flash, go to step 12).

NOTE: For identifying circuits referred to in testing, see appropriate wiring diagram in L - WIRING DIAGRAMS article in this section.

3) Check for battery voltage at terminal No. 1 of security alarm module relay (located in relay center under glove box). If less than battery voltage is present, repair open to fuse No. 7 (15-amp) and retest. If system does not operate properly, go to next step. If battery voltage is present, go to step 5). If system operates properly, stop test procedure.

NOTE: If SECURITY light comes and remains on with ignition on, the Chrysler Collision Detection (CCD) bus communication with the PCM has been lost. After servicing vehicle ensure that system operates properly. A malfunctioning anti-theft system may keep engine from starting.

4) Using an ohmmeter, check continuity between security alarm module relay terminal No. 2 and headlight feed wires. If continuity

exists, replace security alarm module relay and retest. If continuity does not exist, repair open in wiring circuit as necessary and retest.

5) Check for battery voltage at security alarm module relay terminal No. 3. If battery voltage is not present, repair open in wiring circuit as necessary. If battery voltage is present, go to step 7). If less than battery voltage is present, turn ignition switch to RUN position, then turn ignition off.

6) Check continuity between security alarm module relay pins No. 3 and 5. If continuity does not exist, replace security alarm module relay and retest. If continuity exist, check continuity between security alarm module terminal No. 7 (located behind center cluster bezel on instrument panel) and security alarm module relay pin No. 5. If continuity exists, replace security alarm module and retest. If continuity does not exist, repair open in wiring circuit as necessary and retest.

7) Turn ignition switch to RUN position, then turn ignition off. Check continuity between security alarm module relay pin No. 3 and ground. If continuity does not exist, repair open in wiring circuit as necessary and retest. If continuity exists, replace security alarm module relay with known good relay. If system does not operate properly, go to next step. If system operates properly, stop test procedure.

8) Using an ohmmeter, check continuity between security alarm module relay terminal No. 2 and headlights. If continuity exists, replace security alarm module relay and retest. If continuity does not exist, repair open in wiring circuit as necessary and retest.

9) Turn ignition switch to RUN position, then turn ignition off. If horn does not operate properly, check horn system for malfunction. Repair as necessary and retest. If horn operates properly, check continuity between security alarm module terminal No. 12 and horn relay connector. If continuity exists, replace security alarm module. If continuity does not exist, repair open in wiring circuit and retest.

10) Turn ignition switch to RUN position, then turn ignition off. If flash-to-pass does not operate, check and repair fuse No. 7 (15-amp) as necessary and retest. If flash-to-pass operates, check for battery voltage at security alarm module pin No. 21. If battery voltage is present, replace security alarm module. If voltage is less than battery voltage, repair open in wiring circuit to fuse and retest.

11) Check for battery voltage at lamp outage module pin No. 6. If battery voltage is present, repair open in light system. If voltage is less than battery voltage, check for battery voltage at security alarm module pin No. 14. If battery voltage is present, repair open in wiring circuit between security alarm module and rear lights. If less than battery voltage is present, replace security alarm module.

12) Ensure all doors and liftgate are closed. Verify that SECURITY light is flashing. If SECURITY light is not flashing, check bulb and wiring harness. Repair or replace as necessary. If bulb and wiring are okay, replace security alarm module and retest system.

13) If SECURITY light is flashing, turn ignition switch to OFF position. Remove illuminated entry relay from vehicle. Relay is located on a bracket behind instrument panel.

14) Check theft alarm switches by opening and closing doors and liftgate. Replace switch(es) or repair wiring harness as necessary. If switches are okay, check hood switch by opening and closing hood.

15) Replace hood switch or repair wiring harness as necessary. If hood switch is okay, unlock (with key) each front door and liftgate one at a time to test disarm switches. Replace switch(es) or repair wiring harness as necessary and retest system.

16) If disarm switches are okay, cycle power door locks to

lock position and then unlock. If power door locks do not operate properly, replace door lock switch(es), lock/unlock relay(s) or repair wiring harness as necessary. Retest system.

17) If power door locks operate properly, lock and unlock vehicle with keyless entry transmitter. If power door locks do not operate properly, replace keyless entry transmitter, receiver or repair wiring harness as necessary and retest system.

18) If keyless entry system operates properly, turn ignition switch to ON position and wait 30 seconds. If SECURITY light comes on and stays on, repair or replace CCD bus and wiring as necessary and retest system. If SECURITY light remains off, theft alarm system is operating properly.

NOTE: A functional PCM that has been used in a vehicle equipped with theft alarm system CANNOT be used in another vehicle that is NOT equipped with theft alarm system.

## MOTORS

Idle Air Control (IAC) Motor  
See IDLE CONTROL SYSTEM.

## RELAYS

A/C Compressor Clutch Relay  
See A/C COMPRESSOR CLUTCH under MISCELLANEOUS CONTROLS.

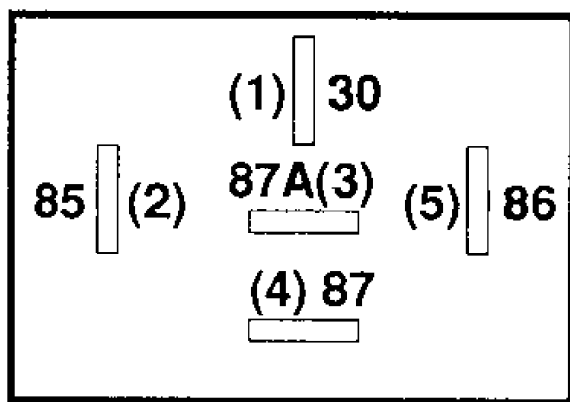
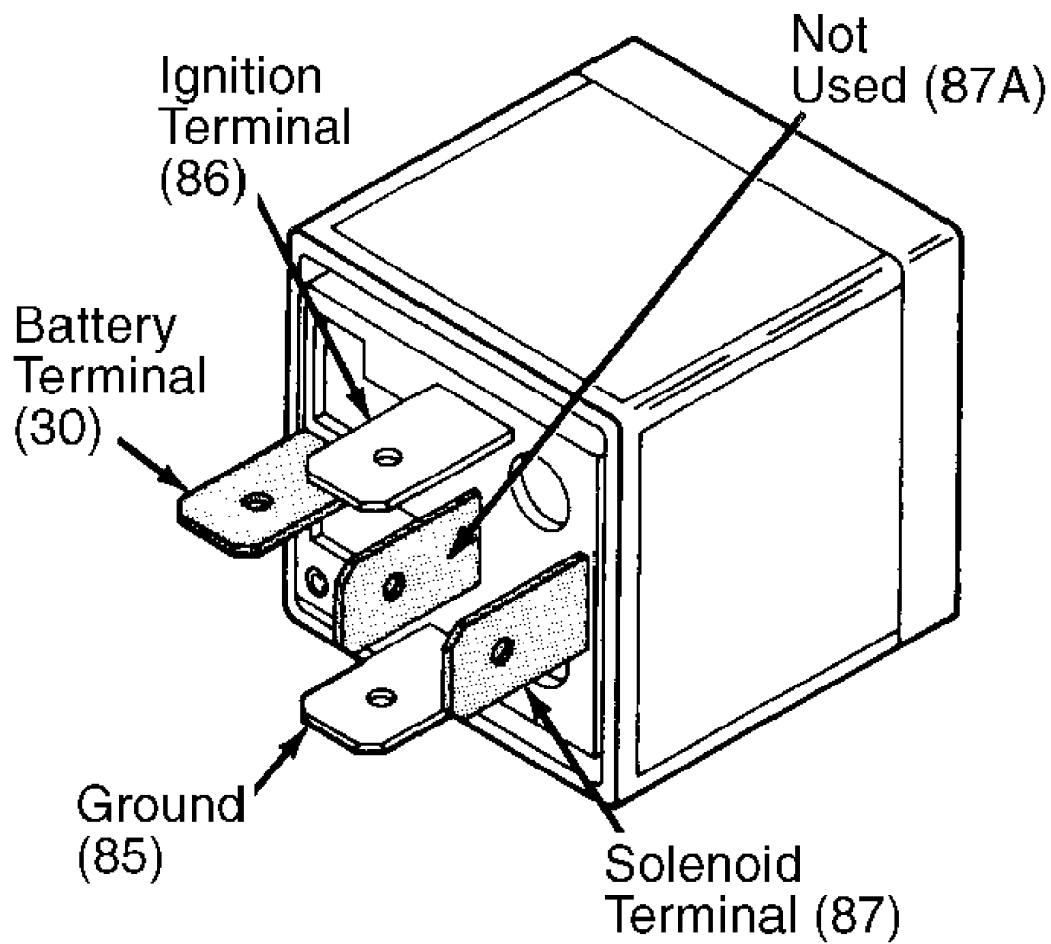
Automatic Shutdown (ASD) Relay  
See appropriate ASD relay tests in G - 2.5L & 4.0L TESTS W/  
CODES article in this section.

Fuel Pump Relay  
See FUEL PUMP RELAY under FUEL DELIVERY.

Radiator (Cooling) Fan Relay  
See RADIATOR (COOLING) FAN under MISCELLANEOUS CONTROLS.

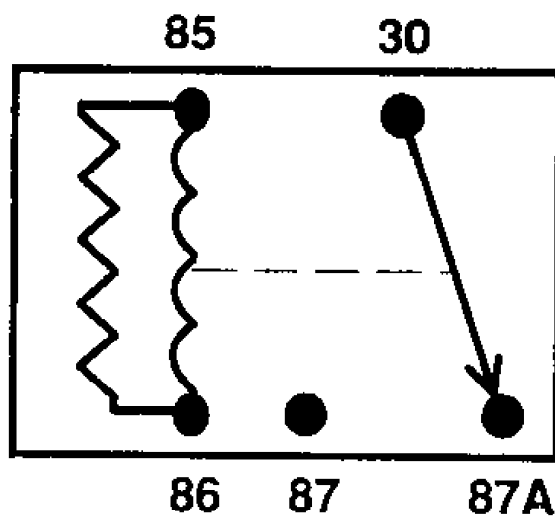
Starter Motor Relay  
Some relays have battery voltage supplied to terminal No. 30. Others have battery voltage supplied to terminals No. 87 or 87A. See Fig. 2. In de-energized position, relay should have continuity between terminals No. 87A and No. 30. Resistance value between terminals No. 85 and No. 86 should be 70-80 ohms for resistor type relays or 81-91 ohms for diode type relays.





BOTTOM VIEW OF RELAY

91D13972



DE-ENERGIZED RELAY

Fig. 2: Identifying Relay Terminals & Testing Relays (Typical)  
Courtesy of Chrysler Corp.

## FUEL DELIVERY

**NOTE:** Always relieve fuel pressure before disconnecting any fuel injection-related component. Also see appropriate fuel delivery system or fuel injector control circuit tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

### Fuel System Pressure Release Procedure

1) Disconnect negative battery cable. Slowly open fuel tank cap to release fuel tank pressure. Remove protective cap from pressure test port on fuel rail.

2) Using Fuel Pressure Gauge Tool Set (5069), obtain fuel pressure gauge and hose assembly. Remove gauge from hose. Place gauge end of hose in approved gasoline container. Place shop towel under test port. Screw other end of hose onto fuel pressure test port. Release fuel pressure. After pressure is released, remove hose from test port. Install protective cap on pressure test port.

3) If gauge tool set is not available, perform step 1). Using a small screwdriver, wrapped in shop towels, push test port valve in to relieve fuel pressure. Absorb spilled fuel with shop towels. Remove shop towels and dispose properly. Install protective cap on pressure test port.

### Fuel System Pressure Test

1) Remove cap from pressure fitting in fuel rail. See Fig. 3. Using a shop towel to absorb any spilled fuel, connect a 0-60 psi (0-4.22 kg/cm<sup>2</sup>) fuel pressure gauge to pressure fitting on fuel rail. Disconnect vacuum hose from fuel pressure regulator. Start engine.

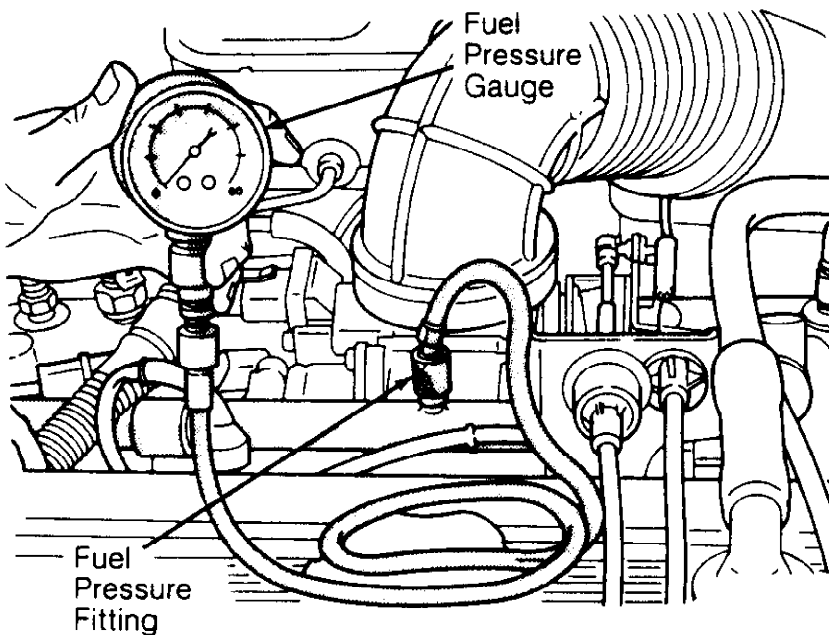


Fig. 3: Testing Fuel System Pressure  
Courtesy of Chrysler Corp.

2) Pressure should be approximately 39 psi (2.74 kg/cm<sup>2</sup>) with vacuum hose disconnected and 31 psi (2.18 kg/cm<sup>2</sup>) with vacuum hose

connected to fuel pressure regulator.

3) If fuel pressure is not 8-10 psi (.56-.70 kg/cm<sup>2</sup>) higher with vacuum hose disconnected from fuel pressure regulator, inspect vacuum hose for blockage, leaks, kinks or other damage. If vacuum hose is okay, replace fuel pressure regulator.

4) If fuel pressure exceeds 45 psi (3.1 kg/cm<sup>2</sup>), check fuel return line for kinks or blockage. If fuel pressure is low, release fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE PROCEDURE heading above. Disconnect fuel return line on fuel rail near fuel pressure regulator. Connect 5/16" fuel hose between disconnected fuel return line and fuel rail.

CAUTION: Fuel pressure will rise as high as 100 psi (6.9 kg/cm<sup>2</sup>) when fuel return line is pinched off. Ensure connections are properly secured. DO NOT pinch off hose for longer than 5 seconds.

5) Restart vehicle and let engine idle. Momentarily pinch off hose connected to fuel return line. Note fuel gauge pressure reading. Pressure should rise to approximately 75 psi (5.2 kg/cm<sup>2</sup>) within 2 seconds.

6) If fuel pressure rises as specified, pressure is operating at maximum capacity and is correct. If fuel pressure does not rise as specified, turn engine off. Release fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE PROCEDURE heading above. Raise and support vehicle. Disconnect fuel supply line at inlet (fuel tank side) of fuel filter. Connect 3/8" fuel hose between fuel filter and fuel supply line.

7) Restart vehicle and let engine idle. Momentarily pinch off hose connected to fuel supply line. Note fuel pressure gauge reading. Pressure should rise to approximately 75 psi (5.2 kg/cm<sup>2</sup>) within 2 seconds. If fuel pressure rises as specified, but pressure is not same at fuel rail, check for plugged or restricted fuel filter. Also check fuel supply line between fuel filter and fuel rail for kinks or blockage.

#### Fuel Pressure Leak-Down Test

1) Remove cap from pressure fitting on fuel rail. See Fig. 3. Connect a 0-100 psi (0-6.9 kg/cm<sup>2</sup>) fuel pressure gauge to pressure fitting on fuel rail. Start and run engine at idle.

2) Turn engine off and note fuel pressure gauge reading. Leave fuel pressure gauge connected. Allow 30 minutes to elapse and then compare fuel pressure gauge reading to reading taken when engine was turned off.

3) A pressure drop up to 20 psi (1.4 kg/cm<sup>2</sup>) within 30 minutes is within specification. If pressure drop is not within specification, go to next step. If pressure drop is within specification, the fuel pump outlet check valve and fuel pressure regulator are operating correctly.

4) Release fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE PROCEDURE heading above. Disconnect both fuel lines at fuel rail near fuel pressure regulator. Connect 3/8" fuel hose between disconnected fuel supply line and fuel rail. Connect 5/16" fuel hose between disconnected fuel return line and fuel rail.

5) Start engine and record fuel pressure gauge reading. Turn engine off. Pinch off hose connected to fuel return line. Allow 30 minutes to elapse. If pressure drop is within specification, go to next step. A pressure drop of more than 20 psi (1.4 kg/cm<sup>2</sup>) within 30 minutes indicates pressure is bleeding past fuel pump outlet check valve. Replace fuel pump assembly, located in fuel tank.

6) Pinch off hose connected to fuel supply line. Allow 30 minutes to elapse. A pressure drop of more than 20 psi (1.4 kg/cm<sup>2</sup>) within 30 minutes indicates pressure is bleeding past fuel pressure

regulator. Replace fuel pressure regulator.

#### Fuel Pump Capacity Test

1) Release fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE PROCEDURE heading above. Disconnect fuel supply line at fuel rail near fuel pressure regulator. Connect 3/8" fuel hose to disconnected fuel supply line. Insert other end of hose into approved gasoline container. Start engine. Check fuel pump flow rate (capacity).

2) A good fuel pump will deliver at least 1.05 qts. (1.0L) of fuel per minute with return line hose pinched off. If fuel pump capacity is incorrect, inspect fuel supply system for a plugged filter or plugged fuel pump inlet filter.

#### Fuel Pump Relay

Some relays have battery voltage connected to terminal No. 30. Others have battery voltage connected to terminals No. 87 or 87A. See Fig. 2. In de-energized position, relay should have continuity between terminals No. 87A and No. 30. Resistance value between terminals No. 85 and No. 86 should be 70-80 ohms for resistor type relays, or 81-91 ohms for diode type relays.

## FUEL CONTROL

#### Fuel Injectors

Disconnect injector from wiring harness. Connect ohmmeter on injector terminals. Resistance should be about 13.3-15.7 ohms at 68°F (20°C).

#### Oxygen (O2) Sensor

See OXYGEN (O2) SENSOR (HEATING ELEMENT) under ENGINE SENSORS & SWITCHES.

## IDLE CONTROL SYSTEM

#### Idle Air Control (IAC) Motor

1) Set parking brake and block drive wheels. Route all Exerciser Tester (7558) cables away from cooling fans, drive belt, pulleys, and exhaust components. Return engine idle speed to normal before disconnecting exerciser.

2) With ignition off, disconnect IAC motor connector at throttle body. Plug in exerciser tester harness connector into IAC motor. Connect Red clip of exerciser to battery positive terminal.

3) Connect Black clip to battery negative terminal. Red light on exerciser will flash if exerciser is properly connected. Start engine. Move exerciser switch to HIGH position. Engine speed should increase. Move switch to LOW position. Engine speed should decrease.

4) If engine idle speed changes while using exerciser, IAC motor is working properly. Return engine speed to normal idle and disconnect exerciser from IAC motor.

5) If engine idle did not change, turn ignition off. DO NOT disconnect exerciser from IAC motor. Remove IAC motor from throttle body. With ignition off, cycle the exerciser switch between HIGH and LOW positions. Pintle should move in and out of motor.

CAUTION: When checking IAC motor operation with motor removed from throttle body, DO NOT extend pintle more than 1/4" (6.35 mm), as pintle may separate from motor. The IAC motor must be replaced if pintle separates from motor.

6) If pintle still does not move, replace IAC motor. Start engine and test replacement motor. If pintle now operates properly,

check IAC motor bore in throttle body and clean if necessary.  
Reinstall IAC motor and retest.

7) If throttle body is clear of obstructions, USE A Chrysler Corp. Diagnostic Readout Box II (DRB-II) tester and refer to appropriate IAC motor tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.

## **IGNITION SYSTEM**

### **TIMING CONTROL SYSTEMS**

Ignition timing is electronically controlled by Powertrain Control Module (PCM). Base ignition timing is NOT adjustable with this system. PCM controlled ignition system consists of coolant temperature sensor, crankshaft position sensor, distributor (includes rotor and camshaft position sensor), ignition coil, manifold absolute pressure sensor and throttle position sensor. See ENGINE SENSORS & SWITCHES for component testing.

## **EMISSION SYSTEMS & SUB-SYSTEMS**

### **CRANKCASE VENTILATION SYSTEM**

System and component testing information is not available from manufacturer.

### **FUEL EVAPORATION**

System and component testing information is not available from manufacturer.

## **MISCELLANEOUS CONTROLS**

### **A/C COMPRESSOR CLUTCH**

A/C Compressor Clutch Relay

Some relays have battery voltage supplied to terminal No. 30. Other have battery voltage supplied to terminals No. 87 or No. 87A. See Fig. 2. In de-energized position, relay should have continuity between terminals No. 87A and No. 30. Resistance value between terminals No. 85 and No. 86 should be 70-80 ohms for resistor type relays, or 81-91 ohms for diode type relays.

NOTE: Also see appropriate A/C clutch relay circuits tests in G - 2.5L & 4.0L TESTS W/ CODES article in the ENGINE PERFORMANCE Section.

### **RADIATOR (COOLING) FAN**

Radiator (Cooling) Fan Relay

Some relays have battery voltage connected to terminal No. 30. Other have battery voltage supplied to terminals No. 87 or No. 87A. See Fig. 2. In de-energized position, relay should have continuity between terminals No. 87A and No. 30. Resistance value between terminals No. 85 and No. 86 should be 70-80 ohms for resistor type relays, or 81-91 ohms for diode type relays.

NOTE: Also see appropriate radiator (cooling) fan relay circuit tests in G - 2.5L & 4.0L TESTS W/ CODES article in this section.



# 97V069000: INSPECT FRAME RAIL FOR CRACKS - REINFORCE

1993 Jeep Cherokee

## NHTSA RECALL BULLETIN

Model(s): 1993-96 Jeep Cherokee  
Campaign No: 97V069000  
Number of Affected Vehicles: 2500  
Beginning Date of Manufacture: 1992 JUL  
Ending Date of Manufacture: 1996 OCT

## DESCRIPTION OF DEFECT:

During assembly of the frame, a fillet weld that joins the inner steering gear attachment reinforcement to the frame rail, was omitted.

## CONSEQUENCE OF DEFECT:

Due to high steering load events, vehicles can exhibit broken steering gear attaching bolts or frame rail cracking at the steering gear attaching point increasing the risk of a vehicle crash.

## CORRECTIVE ACTION:

Dealers will inspect the vehicles for cracks in the frame rail.

Vehicles that show cracks will be equipped with reinforcement plates. Vehicles that are found to be free of cracks will have a slot cut in the cross member and the fillet weld will be added.

## OWNER NOTIFICATION:

Owner notification is expected to begin during May 1997.

Owners who take their vehicles to an authorized dealer on an agreed upon service date and do not receive the free remedy within a reasonable time should contact Chrysler at 1-800-853-1403. Also contact the National Highway Traffic Safety Administration's Auto Safety Hotline at 1-800-424-9393.

## ADDITIONAL INFORMATION:

The National Highway Traffic Safety Administration operates Monday through Friday from 8:00 AM to 4:00 PM, Eastern Time. For more information call (800) 424-9393 or (202) 366-0123. For the hearing impaired, call (800) 424-9153.

# INSTRUMENT PANEL

## 1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Instrument Panels

Jeep; Cherokee

### DESCRIPTION

Instrument panel is supplied voltage through gauges fuse. A printed circuit on rear of instrument cluster distributes voltage to gauges and indicators.

Emission Maintenance Timer

Emission Maintenance Timer and Indicator Light activate when mileage reaches scheduled maintenance interval of 82,500 miles. Timer can be reset using DRB-II.

### TESTING

#### GAUGE TESTING

Compare resistance values of malfunctioning gauge to specifications. See OIL PRESSURE GAUGE RESISTANCE, FUEL GAUGE RESISTANCE and TEMPERATURE GAUGE RESISTANCE tables.

##### OIL PRESSURE GAUGE RESISTANCE TABLE

Oil Pressure (psi)	Ohms
0 .....	1
40 .....	46
80 .....	87

##### FUEL GAUGE RESISTANCE TABLE

Application	Ohms
Empty .....	105
1/2 Full .....	33
Full .....	5

##### TEMPERATURE GAUGE RESISTANCE TABLE

Application & Test Temperature	Ohms
100°F (38°C) .....	1365.0
220°F (104°C) .....	93.5
260°F (127°C) .....	55.1

#### BRAKE INDICATOR INOPERATIVE

1) Turn ignition switch on with engine off. Apply parking brake, and unplug brake warning light switch connector. Connector is located below brake master cylinder at left rear of engine compartment. Jumper between brake warning light switch connector Gray/White wire and ground. If bulb is good and indicator lights,



repair open circuit to indicator.

2) With ignition switch off, measure resistance between brake warning switch connector Gray wire (changes to Gray/White wire at splice) and ground. If reading is zero ohms, check switch and/or brake system. If reading is not zero ohms, repair open circuit to parking brake switch ground.

## **COOLANT TEMPERATURE GAUGE INOPERATIVE**

Turn ignition switch on with engine off. Disconnect coolant temperature sending unit connector (located at left rear of engine). If needle does not indicate at low end of scale, touch connector Violet/Yellow wire to ground. If needle indicates at high end of scale, replace sending unit. If needle does not indicate at high end of scale, repair open Violet/Yellow wire to gauge.

## **COOLANT TEMPERATURE INDICATOR LIGHT INOPERATIVE**

Turn ignition switch on with engine off. Disconnect coolant temperature sender connector (located at left rear of engine). Touch connector Violet/Yellow wire to ground. If indicator lights, replace switch. If bulb is good and indicator light remains off, repair open Violet/Yellow wire to instrument cluster terminal.

## **FUEL GAUGE INOPERATIVE**

With ignition on and engine off, disconnect fuel gauge sending unit connector. If needle goes to "E", replace sending unit. If needle does not go to "E", connect fuel gauge sending unit connector and disconnect instrument cluster connector terminal B1. Check resistance of sending unit. If resistance is 5-105 ohms, replace gauge. If resistance is not 5-105 ohms, repair open Dark Blue wire to sending unit.

## **GAUGES & INDICATORS INOPERATIVE**

Check gauge fuses. Replace if blown. Test instrument cluster connector terminal A3 ground wire. See Figs. 1 and 2. If any resistance to ground is detected, repair open Black wire in ground circuit.

## **PANEL LIGHTS: ALL LIGHTS INOPERATIVE, PARKING LIGHTS WORKING**

1) Check PARK fuse and instrument lights fuse. Replace if necessary. Repair short to ground in 12-volt supply wire to blown fuse.

2) Using voltmeter, probe battery side of instrument lights fuse while turning headlight switch dimming rheostat from LO to HI. If results are not zero volts for LO and battery voltage for HI, replace headlight switch.

3) Using DVOM, check resistance at ground (bulb) side of instrument lights fuse with parking lights off. If resistance to ground is almost zero (allowing for bulb filaments), system is good. If resistance is zero ohms, 12-volt supply wire from fuse is shorted to ground. Repair short.

## **LOW FUEL WARNING LIGHT INOPERATIVE**

Turn ignition on with engine off. Disconnect wire to terminal B1 of instrument cluster connector. See Figs. 1 and 2. Wait 10 seconds. If indicator light glows, system is good. Replace sending unit. If indicator light does not glow, replace low fuel warning

module (on back of instrument cluster).

### **OIL PRESSURE GAUGE INOPERATIVE**

1) Turn ignition on with engine off. Disconnect oil pressure sender connector, located on right side of engine, next to distributor. If needle goes to high indication, system is good.

2) If needle does not indicate at high end of scale, touch oil pressure sending unit connector Gray wire to ground. If needle indicates at low end of scale, replace sending unit. If needle does not indicate at low end of scale, repair open in Gray wire circuit to gauge (instrument cluster terminal B7). See Figs. 1 and 2.

### **OIL PRESSURE INDICATOR INOPERATIVE**

Turn ignition on with engine off. Touch oil pressure switch connector Gray wire to ground. If light glows, replace switch. If light does not glow and bulb is good, repair open in Gray wire to instrument cluster connector terminal B7. See Figs. 1 and 2.

### **PART TIME OR 4WD INDICATOR INOPERATIVE**

1) Apply parking brake. Start engine. Place 4WD selector lever in 4WD LOCK or 4WD position. Unplug 4WD switch, and touch harness connector Black/Yellow wire to ground. If indicator light glows, wiring system is good. Check 4WD switch operation, and replace switch if defective.

2) If indicator light does not glow and bulb is good, repair open in Black/Yellow wire circuit to indicator light.

### **TACHOMETER INOPERATIVE**

Tachometer input is from engine PCM pin No. 43. Check Gray/Light Blue wire for short or open circuits. If wire is okay, see appropriate G - TESTS W/CODES article in the ENGINE PERFORMANCE Section.

### **VOLTMETER (GAUGE) INOPERATIVE**

Turn ignition on with engine off. If voltmeter does not indicate battery voltage, check voltage at instrument cluster connector terminal A8. See Figs. 1 and 2. If battery voltage exists at terminal A8, replace voltmeter. If battery voltage does not exist at terminal A8, repair open White/Black wire circuit to gauges fuse.

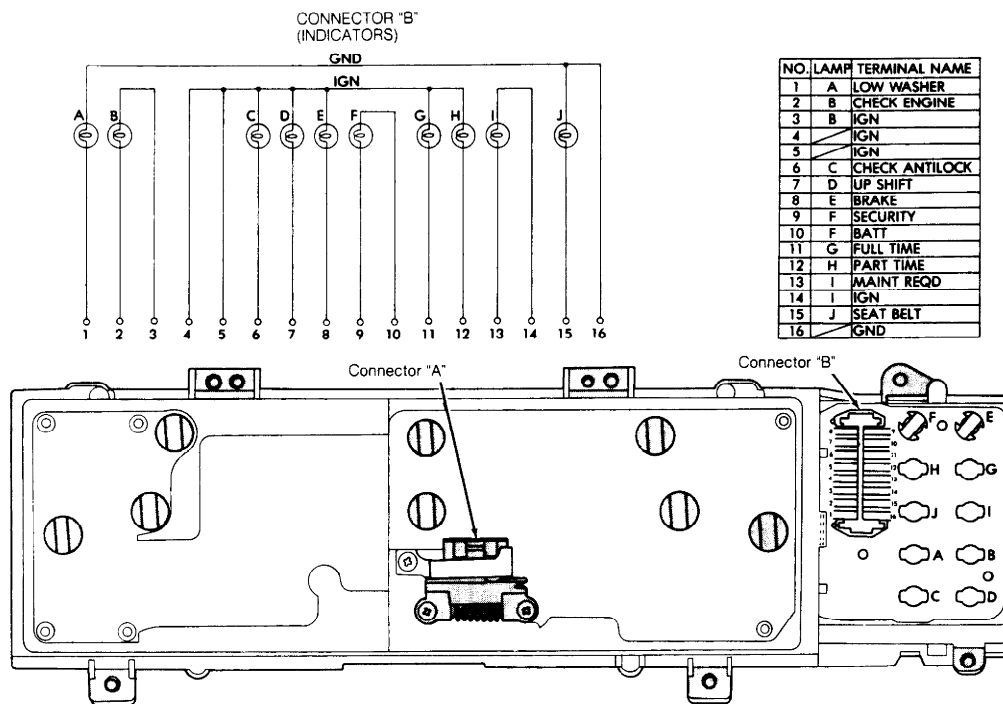
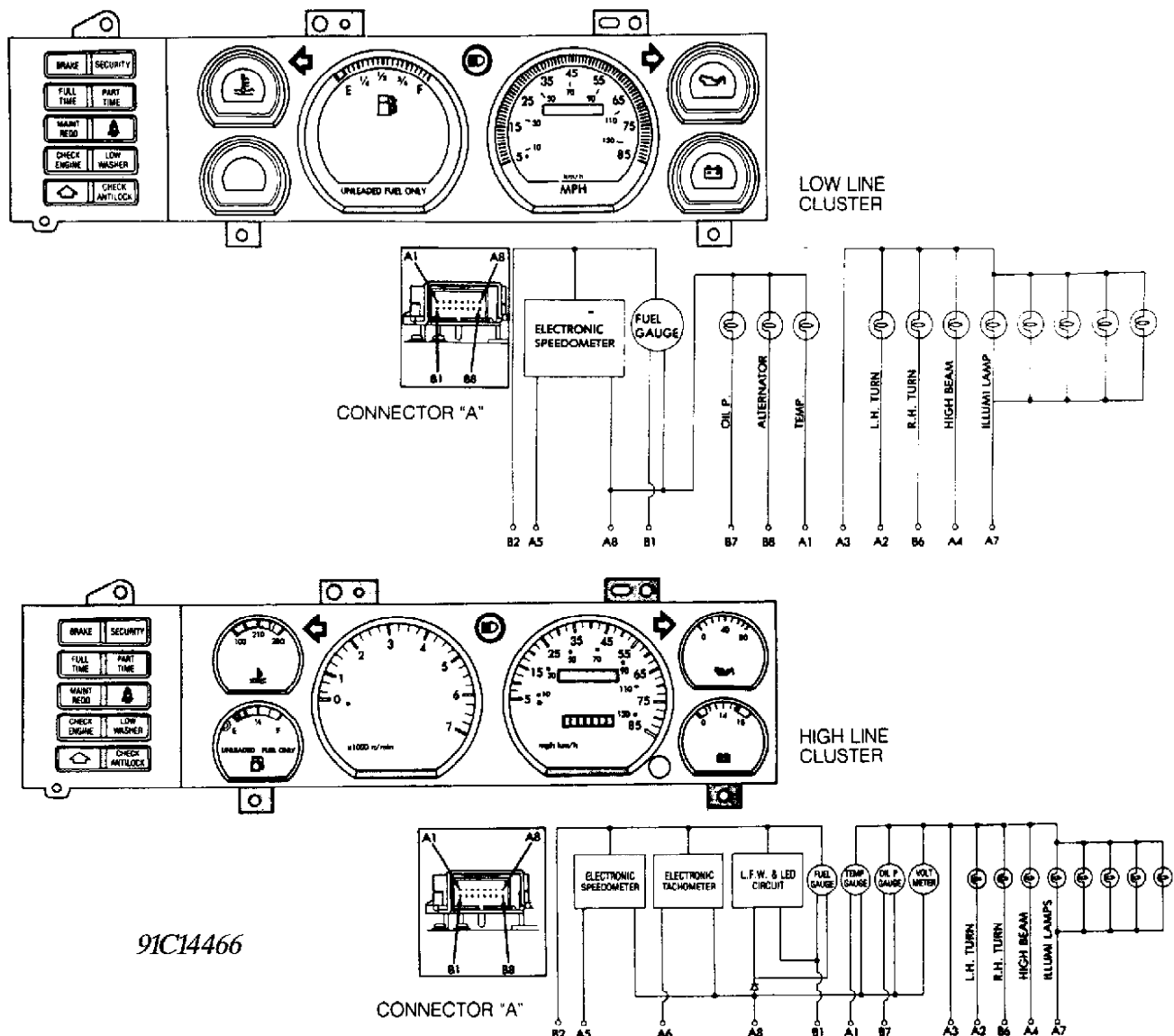


Fig. 1: Instrument Cluster Connector ID & Location  
Courtesy of Chrysler Corp.



91C14466

Fig. 2: Instrument Cluster Connector Terminal ID  
Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

### INSTRUMENT CLUSTER

#### Removal & Installation

1) Disconnect negative battery cable. Remove 4 instrument cluster bezel attaching screws, and unsnap instrument cluster bezel. See Fig. 3. Remove cigarette lighter housing attaching screw. Remove switch housing attaching screws. See Fig. 4.

2) Remove instrument cluster attaching screws. Pull out cluster assembly far enough to disconnect 2 multiple plugs, and remove instrument cluster. See Figs. 5 and 6. To install, reverse removal procedure.

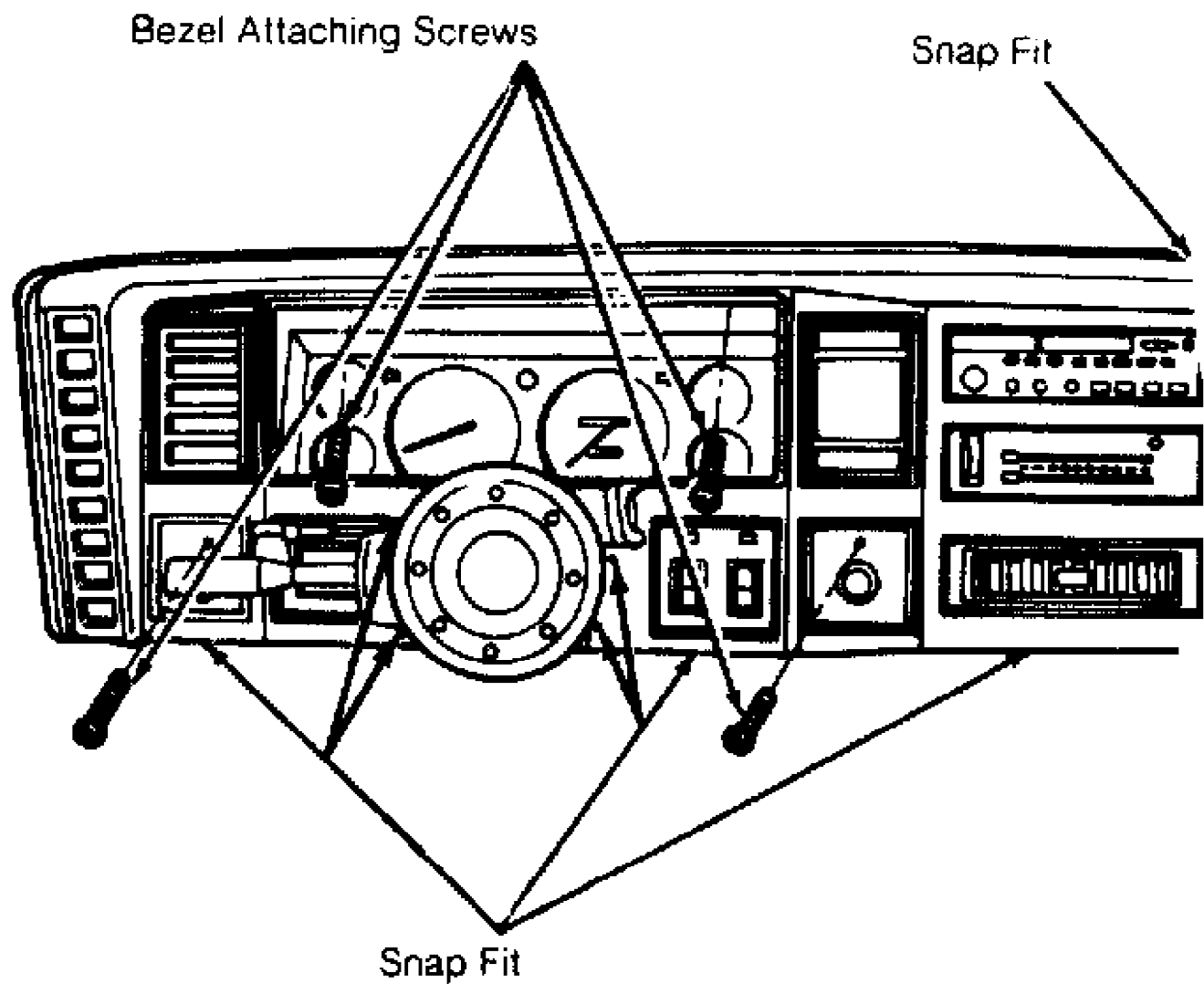


Fig. 3: Removing Instrument Cluster Bezel  
Courtesy of Chrysler Corp.

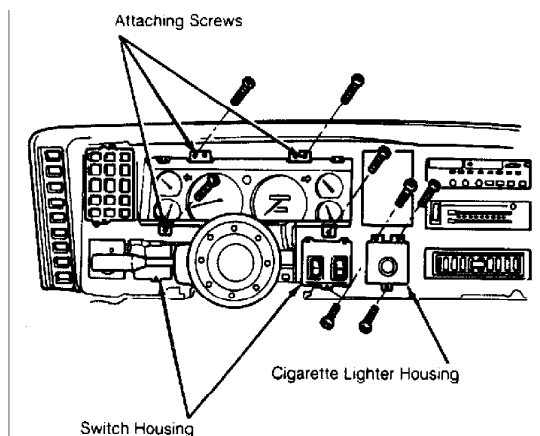
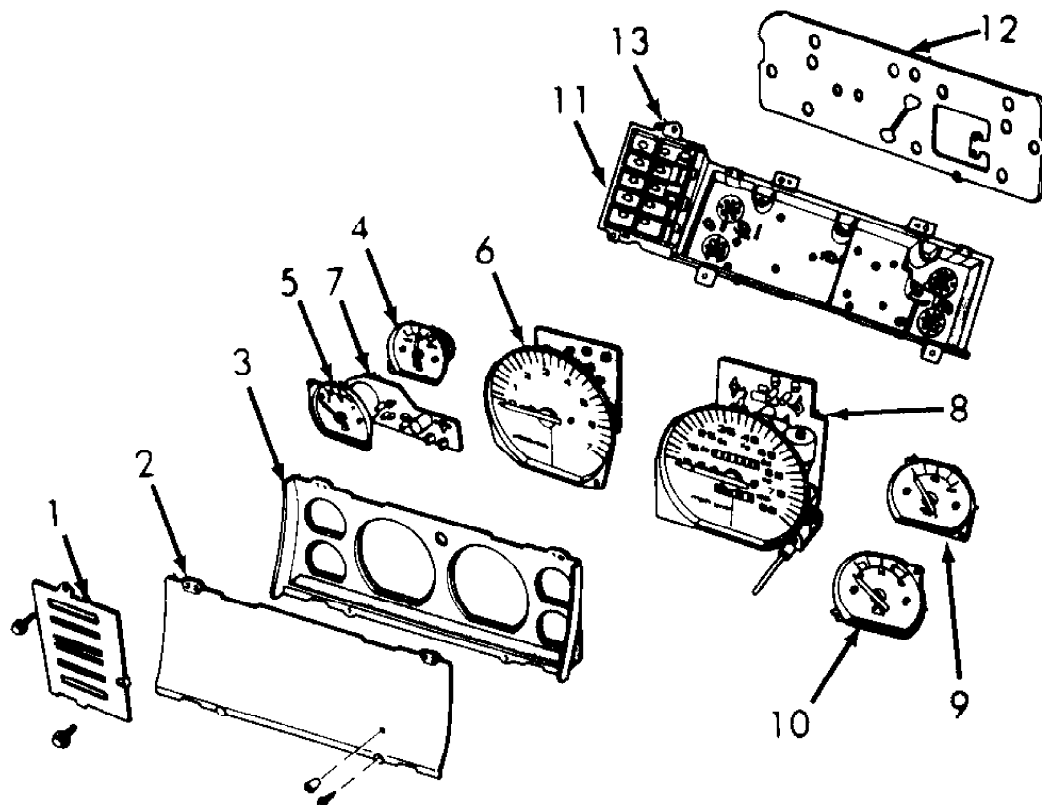


Fig. 4: Removing Instrument Cluster  
Courtesy of Chrysler Corp.



- |                      |                                 |
|----------------------|---------------------------------|
| 1. Tell-Tale Display | 7. Low Fuel Warning Module      |
| 2. Lens              | 8. Speedometer                  |
| 3. Gauge Bezel       | 9. Oil Pressure Gauge           |
| 4. Temperature Gauge | 10. Voltmeter                   |
| 5. Fuel Gauge        | 11. Mounting Bezel              |
| 6. Tachometer        | 12. Printed Circuit (Gauges)    |
|                      | 13. Printed Circuit (Tell-Tale) |

Fig. 5: Exploded View Of Instrument Cluster  
 Courtesy of Chrysler Corp.

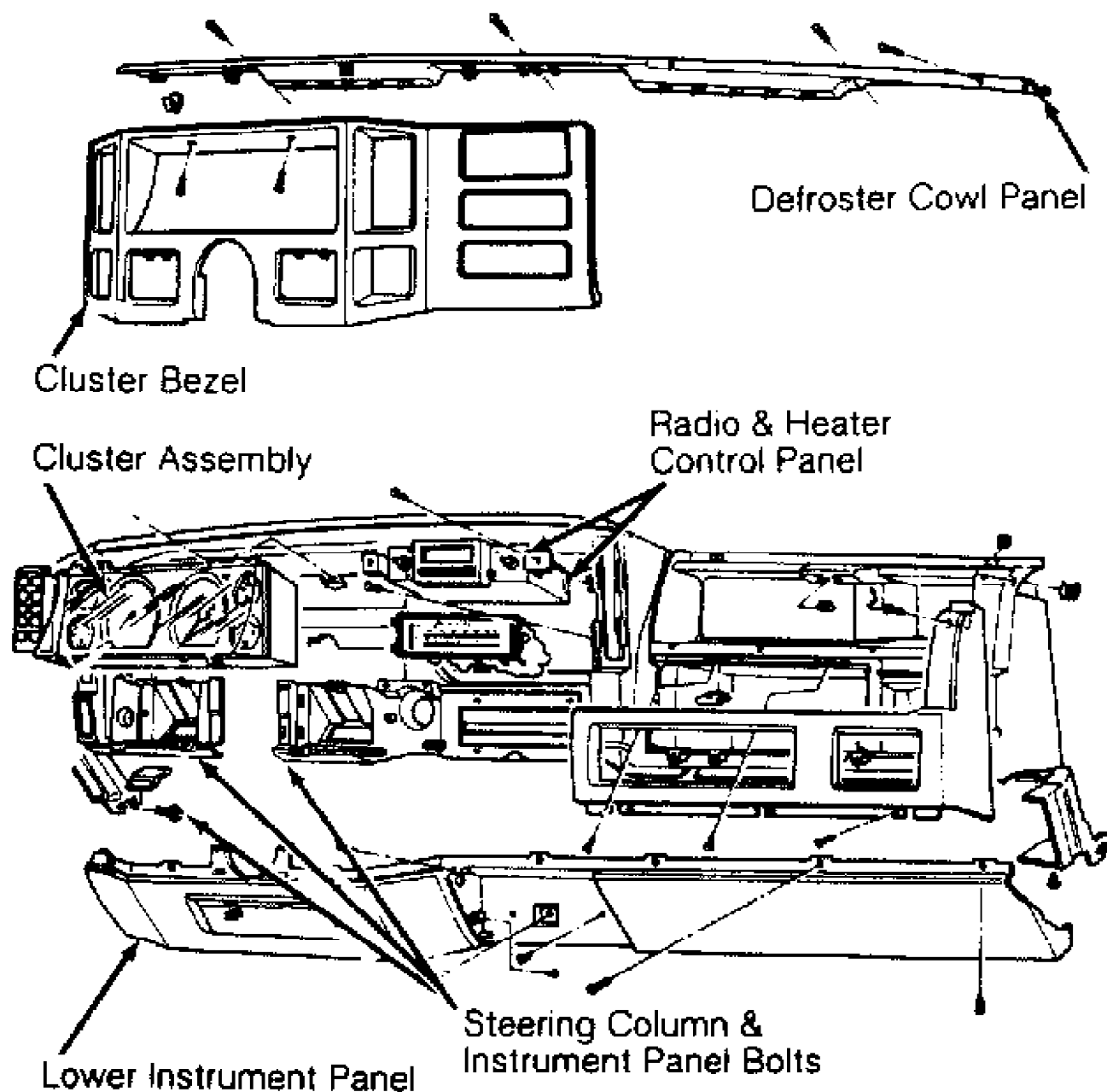


Fig. 6: Exploded View Of Instrument Panel  
Courtesy of Chrysler Corp.

## WIRING DIAGRAMS

See appropriate chassis wiring diagram in WIRING DIAGRAMS.

# JACKING & HOISTING

## 1993 Jeep Cherokee

1993 WHEEL ALIGNMENT  
Chrysler Corp. Jacking & Hoisting

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### JACKING & HOISTING

#### FLOOR JACK

Vehicle may be raised by positioning jack under front or rear frame rails. See Fig. 1.

NOTE: Use sub-frame rail lift points to hoist vehicle. Never raise vehicle with jack under axle tubes, body side sills, steering linkage components, drive shafts, engine/transmission oil pans, fuel tank or front suspension arms.

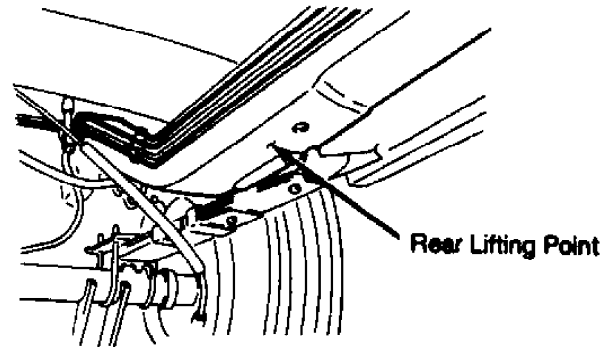
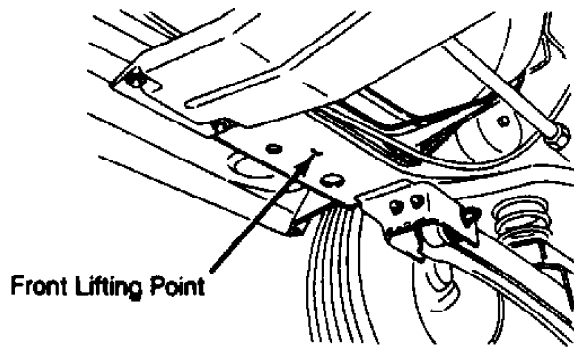


Fig. 1: Identifying Front & Rear Lifting Points  
Courtesy of Chrysler Corp.

#### EMERGENCY JACKING

Except Wrangler

Park vehicle on a firm, level surface. Block tire diagonally opposite tire being changed. Place automatic transmission in Park, manual transmission in Reverse. Set parking brake. Position emergency jack under front or rear axle housing. Raise vehicle.

Wrangler

Park vehicle on a firm, level surface. Block tire diagonally opposite tire being changed. Place automatic transmission in Park, manual transmission in Reverse. Set parking brake. Position emergency jack under front or rear axle housing "U" bolts. Raise vehicle.

#### HOIST

Vehicle may be raised on single or twin-post swiveling arm, or ramp-type drive hoists. If using swiveling arm hoist, ensure lifting pads are positioned evenly at sub-frame lift points. See Fig. 2 and Fig. 3. All hoists should be equipped with proper adapters to support vehicle at frame rails only.



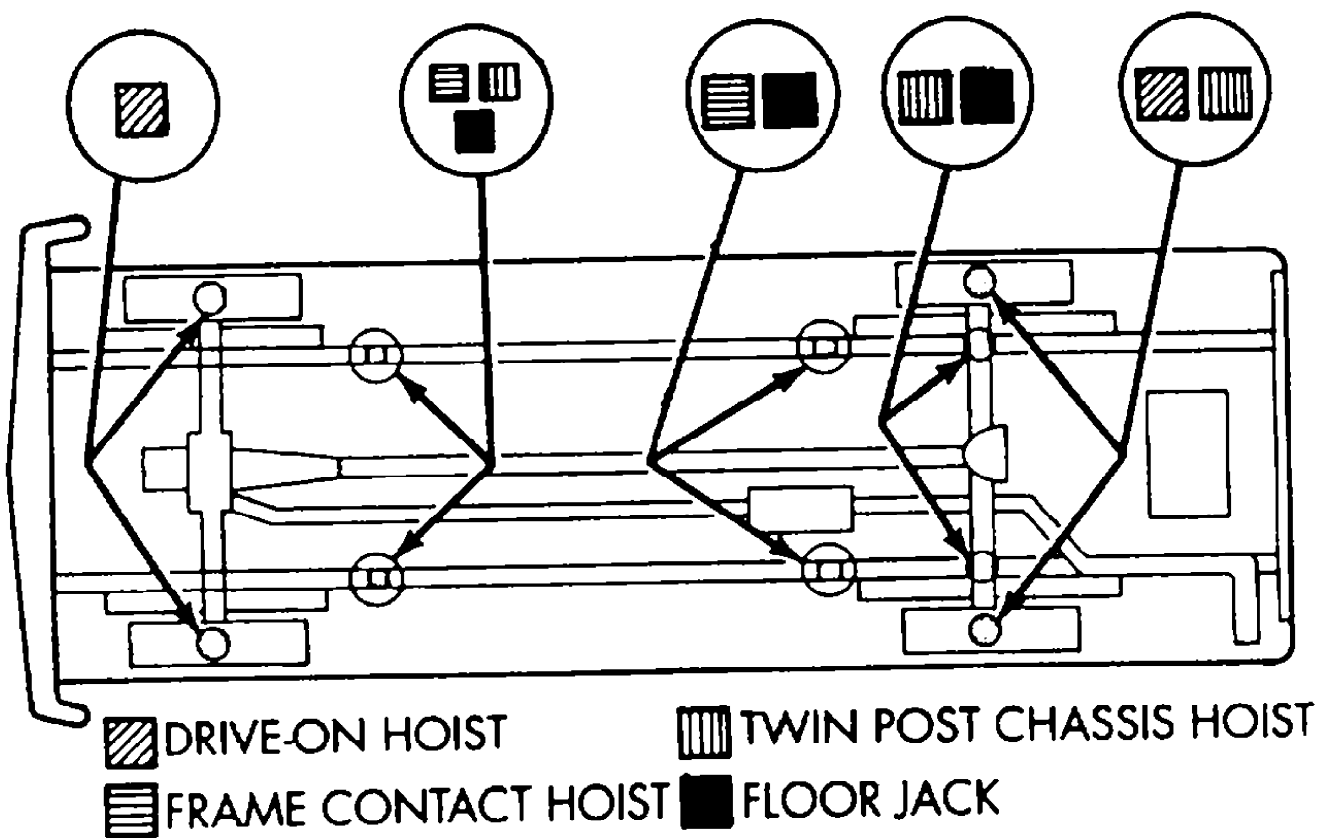
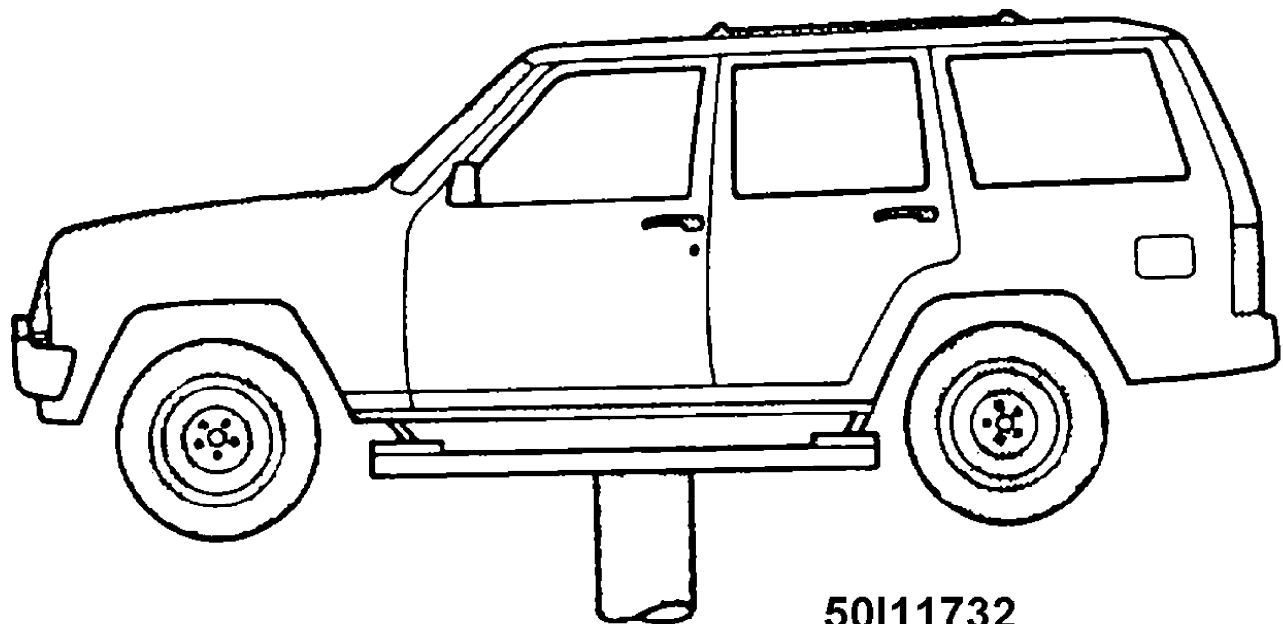


Fig. 2: Hoist Lift Point Locations (Cherokee)  
 Courtesy of Chrysler Corp.

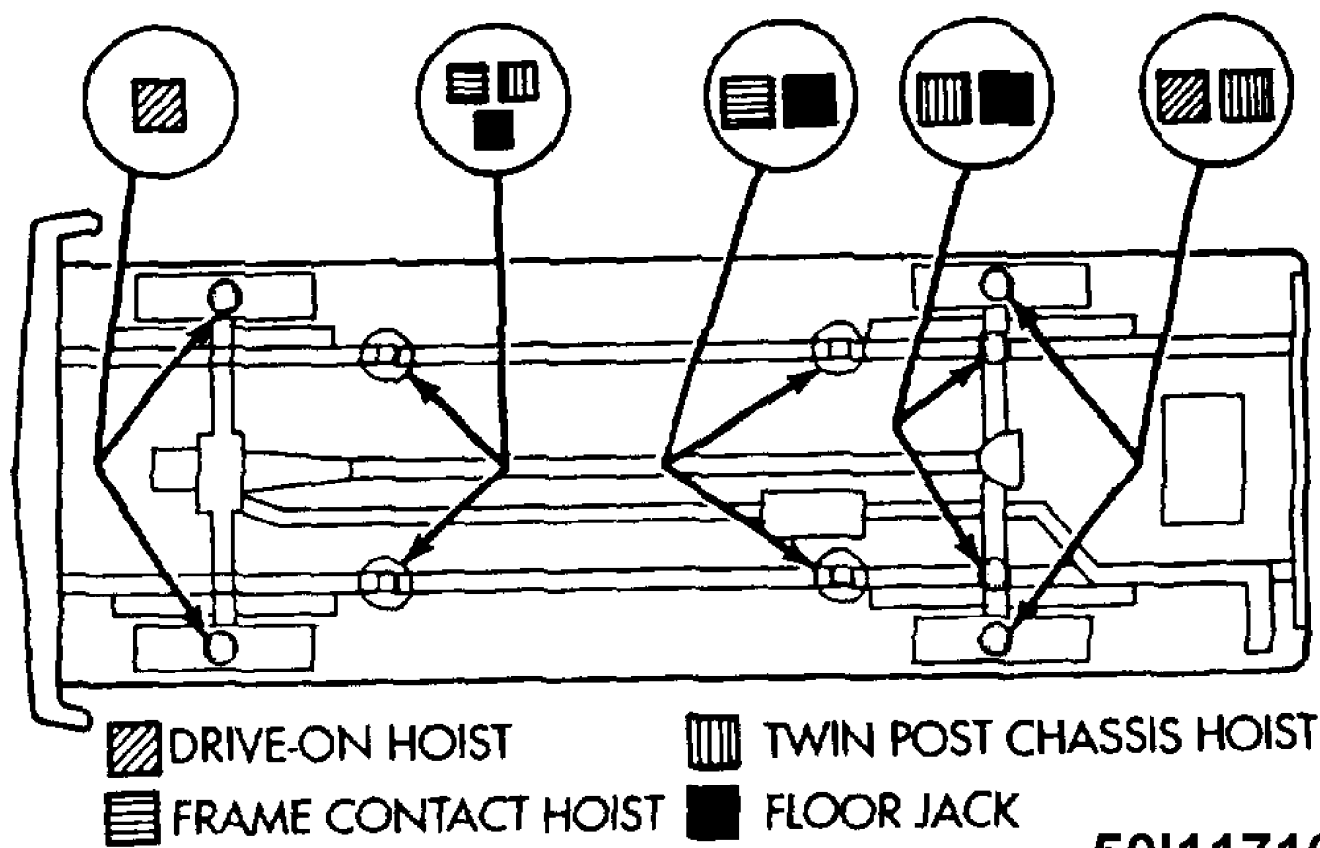
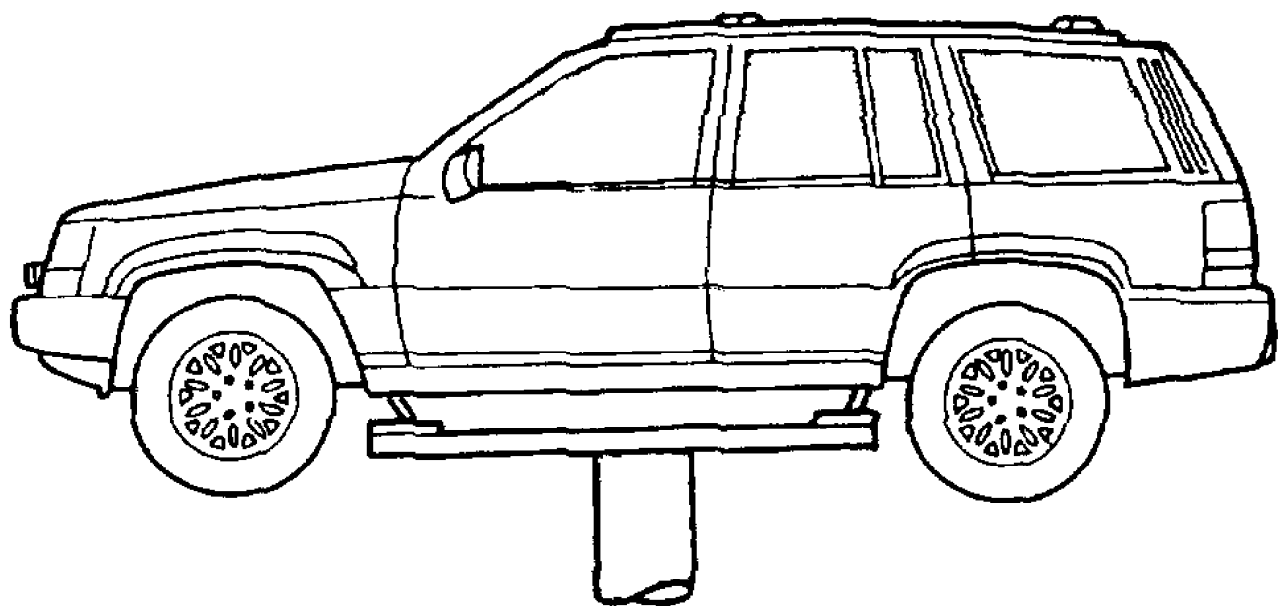


Fig. 3: Identifying Hoist Lifting Points (Grand Cherokee)  
 Courtesy of Chrysler Corp.

5011716

# KEYLESS ENTRY SYSTEM

1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Keyless Entry System

Jeep; Cherokee

## DESCRIPTION & OPERATION

### SYSTEM

The keyless entry system consists of a portable remote control transmitter and a receiver mounted between the sun visors. System operation is based on a coded infrared signal from transmitter to the receiver. The transmitter is programmed into the receiver providing the correct programming sequence is met.

When keyless entry system is activated, the corresponding relay operates supply voltage to motors. The use of either relay determines the polarity of voltage that is supplied to door lock motors.

When keyless entry system is used, the transmitter sends a signal to keyless entry module. If doors are unlocked, the module activates a transistor switch to apply voltage to lock relay coil. The coil is energized to close the normally open contacts of lock relay. Battery voltage from relay is applied to door lock motors to lock the doors. Current flows in same path to ground as it does when master door lock switch is used.

When doors are locked, the keyless entry module applies voltage to unlock relay coil and a similar action takes place to unlock doors.

### TRANSMITTER

The pocket size, solid state transmitter operates on 2, 3 volt lithium (CR1616) batteries. The transmitter is activated by pressing either the lock or unlock button. This closes the internal contacts that complete the battery circuit.

The battery voltage activates the transmitter diode which in turn generates a coded infrared signal. The signal is transmitted as pulses of infrared light.

If the red LED on the side of transmitter does not light when transmitter is activated, the batteries are low.

### RECEIVER

The receiver is in circuit with the electric door lock system. The coded infrared signal is picked up by the receiver diode and is shaped, amplified and decoded by an integrated circuit within the receiver. If the signal code received matches the code in

the receiver memory circuit, the receiver triggers the door lock/unlock relays. The relays complete circuit to electric door lock solenoid to either lock or unlock doors.

To activate the system, aim transmitter diode toward the receiver and press transmitter signal button to lock or unlock doors as desired.

Effective transmitter range is 15 ft. with transmitter positioned no more than 45 degrees from receiver centerline.

## PROGRAMMING

## TRANSMITTER PROGRAMMING

Up to 4 Transmitter Identification Codes (TIC's) can be programmed into receiver at any given time.

1) Open driver's door of vehicle. Leave it open through the programming procedure.

2) Move mechanical door lock lever to the LOCK position.

3) Insert ignition key and turn it to RUN position.

4) Turn ignition to RUN position. Within 20 seconds, aim a transmitter at receiver dome and press lock button, for at least 5 seconds. Once receiver accepts programming code the driver's door will unlock.

5) Once first transmitter has been programmed, additional transmitters (up to 4) may be programmed into receiver. Within 20 seconds of the previous transmitter programming, move the mechanical door lock lever to LOCK position. Aim another transmitter at receiver dome and press LOCK button for at least 5 seconds. The door lock will cycle again.

6) To lock the programmed codes into the receiver, the ignition must be turned off and back on within 20 seconds after programming the last transmitter's code. At that time, all previous codes are erased from the module.

## DIAGNOSIS

### NO DOOR LOCKS OPERATE USING TRANSMITTER

1) Measure resistance at Keyless entry module terminal 10. Meter should read 0 ohms. If not, repair open to ground.

2) Measure voltage at Keyless entry module terminal 1. Meter should read battery voltage. Battery voltage must be at least 9 volts for this system to operate. If not, repair open to Dome fuse.

3) Jumper test leads Keyless entry module terminal 1 to terminal 3. Doors should lock. If OK, replace module. If not, repair open from terminal 3 to Lock relay terminal 1.

4) Jumper test leads Keyless entry module terminal 1 to terminal 4. Door should unlock. If OK, replace module. If not, repair open from terminal 4 to Unlock relay terminal 1.

## REMOVAL & INSTALLATION

### TRANSMITTER SERVICE

If receiver malfunctions, only the receiver will have to be replaced. The new receiver will have to be reprogrammed. If a transmitter is lost, replace the transmitter and reprogram receiver.

Batteries may not be supplied with some replacement transmitters. Be sure to check a replacement transmitter before attempting to activate system.

### TRANSMITTER BATTERY

Removal & Installation

1) Separate transmitter at middle seam. Remove and discard old batteries. Install new CR 1616 batteries. Be sure batteries are installed according to polarity as shown on transmitter battery receptacles.

2) Assemble transmitter and verify correct battery installation. The voltage indicator light will glow when batteries are properly installed.

## RECEIVER SERVICE

### Removal & Installation

1) Remove 2 screws attaching receiver housing to headlining. Pull housing toward rear of vehicle to disengage clip. Disconnect receiver harness connector.

2) Remove circuit board from housing. Reverse the removal procedures to install the receiver.

## DOOR LOCK/UNLOCK RELAY

### Removal & Installation

1) The power window relays are in the relay center, which is located on lower instrument panel trim cover just right of the steering column. Remove both relays.

2) Remove appropriate relay from relay center. To install new relay(s) reverse removal procedure.

## WIRING DIAGRAMS

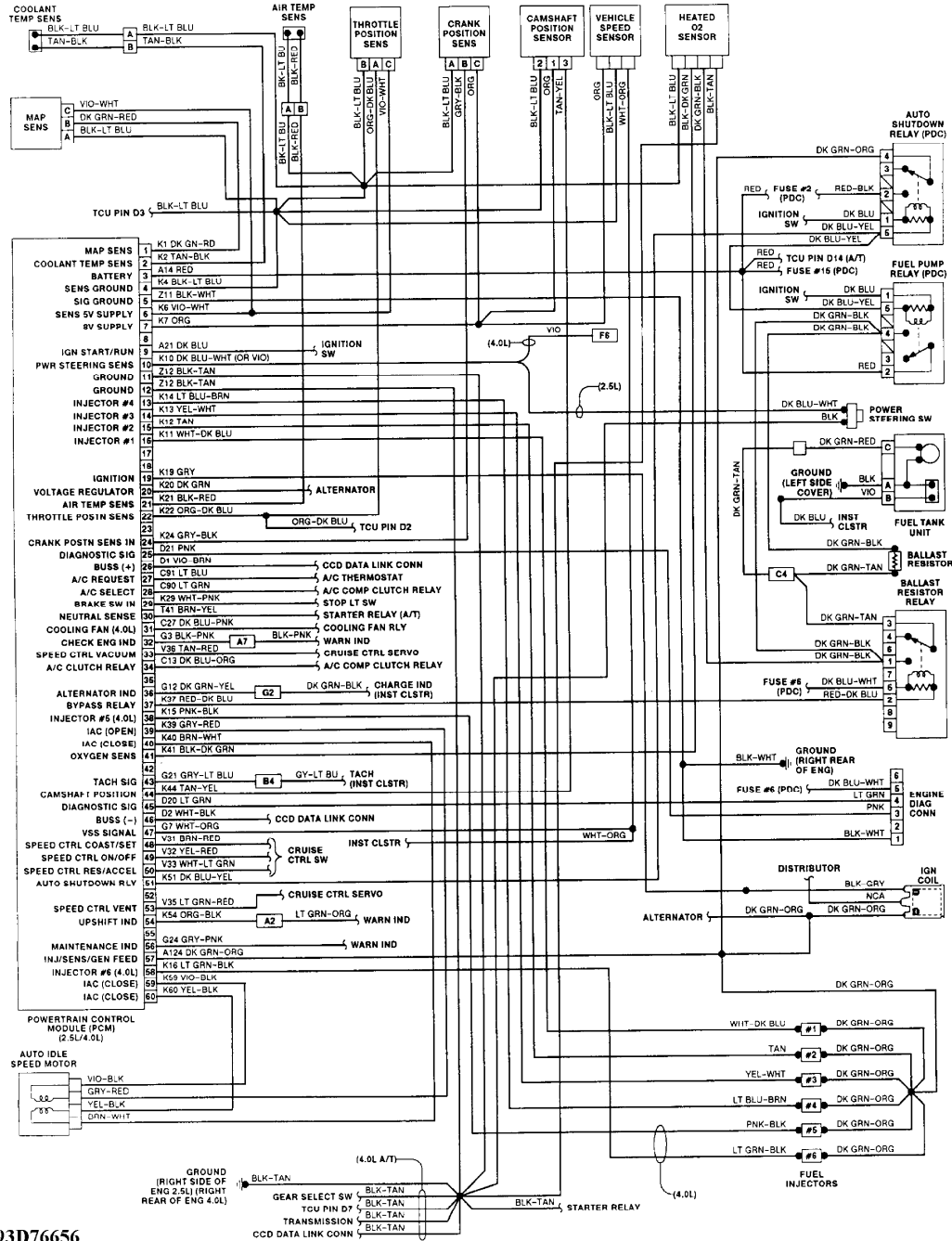
For wiring see WIRING DIAGRAMS article.

# L - WIRING DIAGRAMS

1993 Jeep Cherokee

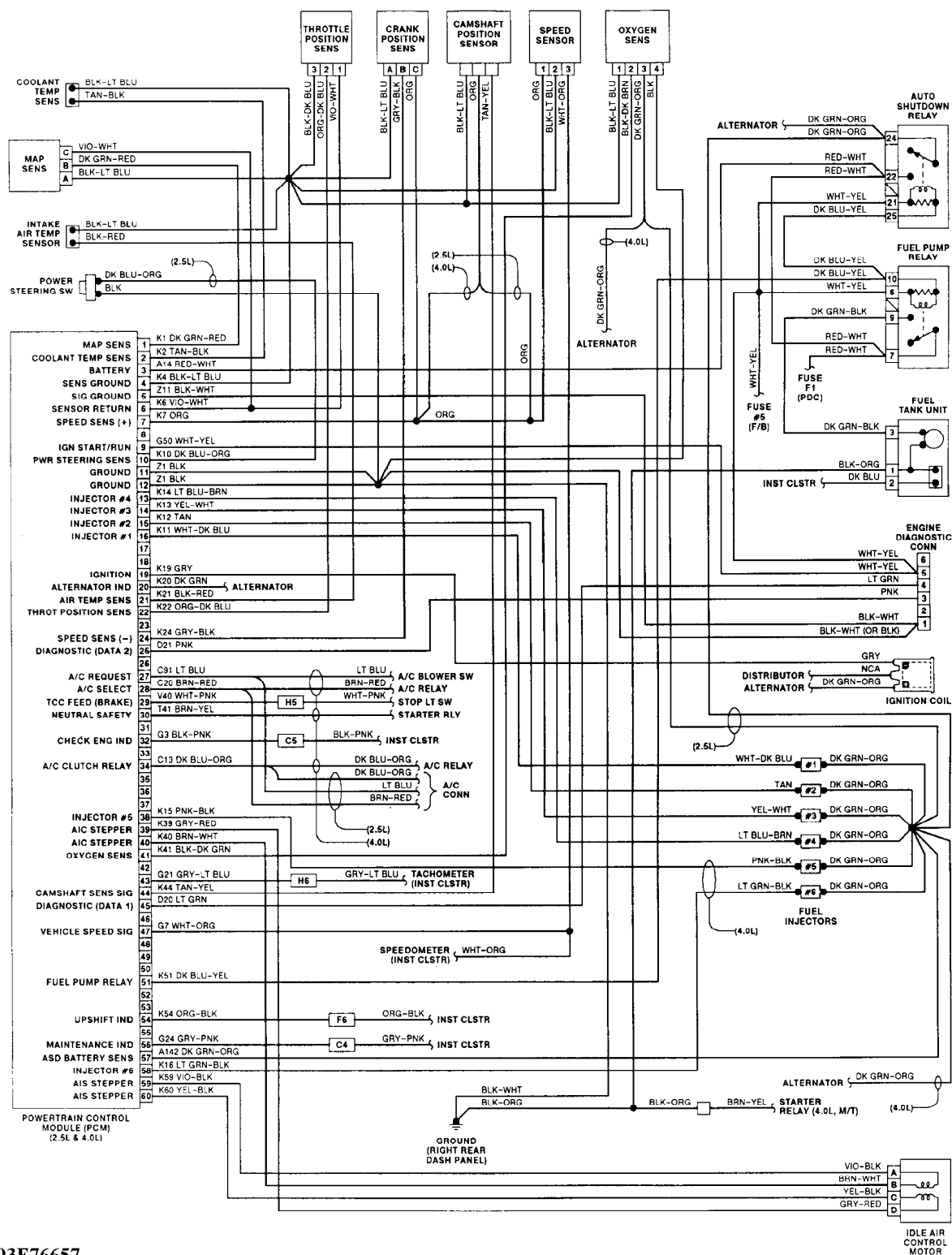
1993 ENGINE PERFORMANCE  
Chrysler Corp. - Wiring Diagrams

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler



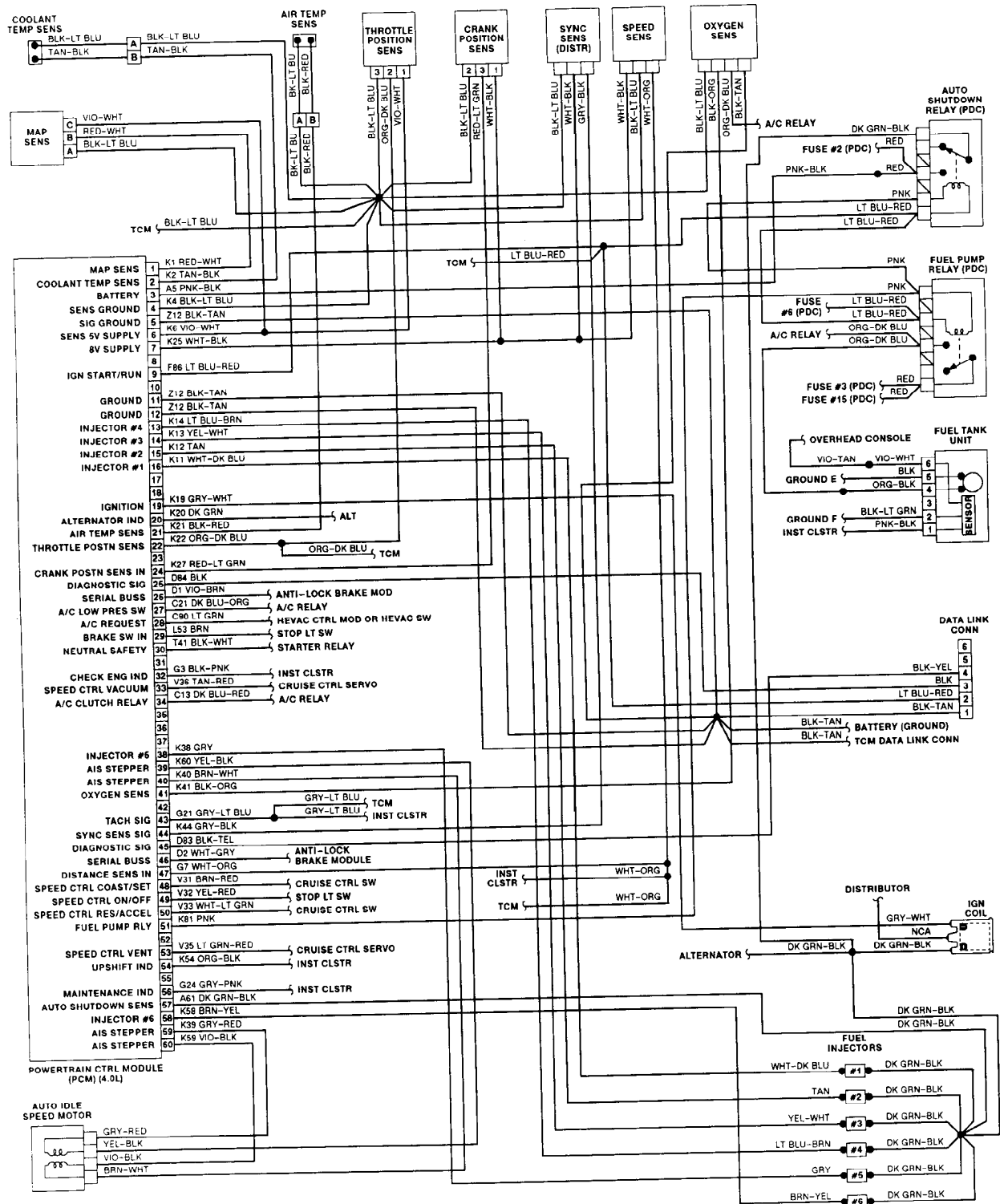
93D76656

Fig. 1: Wiring Diagram (2.5L & 4.0L - Cherokee)



93E76657

Fig. 2: Wiring Diagram (2.5L & 4.0L - Wrangler)



93F76658

Fig. 3: Wiring Diagram (4.0L - Grand Cherokee)



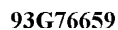


Fig. 4: Wiring Diagram (5.2L - Grand Cherokee & Grand Wagoneer)

## LOCKING HUBS - COMMAND-TRAC & SELEC-TRAC

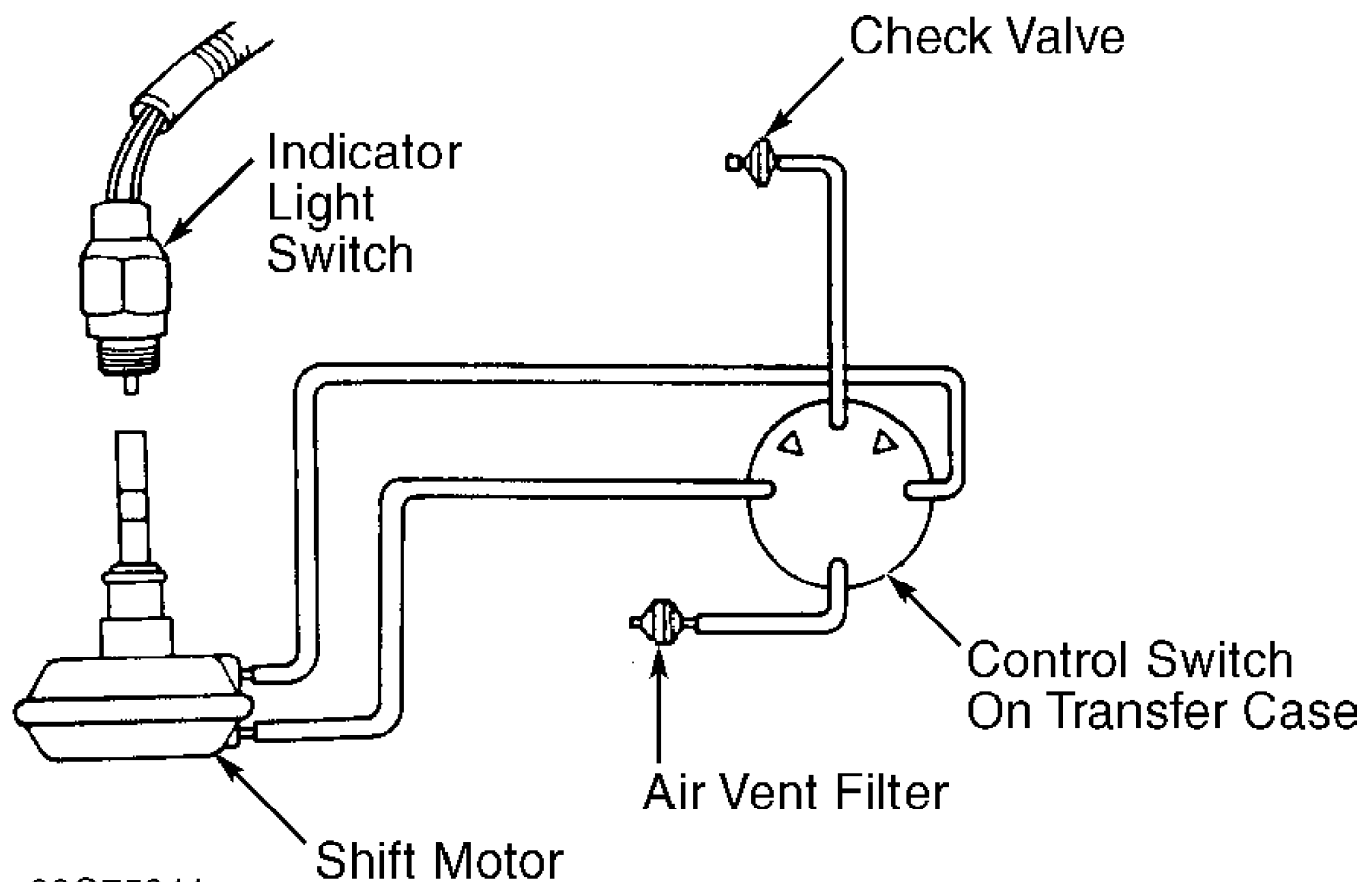
1993 Jeep Cherokee

1993 Drive Axles - Locking Hubs - Command-Trac & Selec-Trac

Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION

The Command-Trac locking hub is used on Wrangler 4WD. This system can be shifted between 2WD and 4WD high range, from inside the vehicle, while vehicle is moving. Command-Trac utilizes a vacuum operated shift motor to engage or disengage front drive axle shaft. Vehicle speed must be reduced to 2-3 MPH to shift into or out of 4WD low range. See Fig. 1.



93G75941

Fig. 1: Command-Trac Vacuum Control System  
Courtesy of Chrysler Corp.

Selec-Trac locking hub is used on 4WD Cherokee. Selec-Trac utilizes a non-disconnect front axle. Engagement of 2WD or 4WD is accomplished at transfer case by means of mechanical shift linkage. System allows full or part time 4WD. Selec-Trac can be shifted into 2WD or 4WD modes from inside the vehicle at any speed.

NOTE: Grand Cherokee & Grand Wagoneer utilize Quadra-Trac full time 4WD system and DO NOT use Command-Trac or Selec-Trac 4WD system.

## TROUBLE SHOOTING

### 2WD TO 4WD

Place mode select switch in 4WD position while driving vehicle 2-3 MPH (Command-Trac). Axle shift should be accompanied by a ratcheting sound followed by an audible mechanical engagement. Transfer case should shift after axle shifts, accompanied by hissing sound from mode selector switch.

### 4WD TO 2WD

1) Place mode select switch in 2WD position. Transfer case should shift to 2WD and not allow shifting into 4WD or LO range. Axle should shift after transfer case shifts.

2) To determine if front axle has completed a shift out of 4WD into 2WD, position mode select switch back to 4WD position while operating vehicle at slow speed. If vehicle shifts into 2WD, axle will ratchet. If shift is not completed, transfer case will shift into 4WD and hissing sound will come from mode select switch.

## ON-VEHICLE TESTING

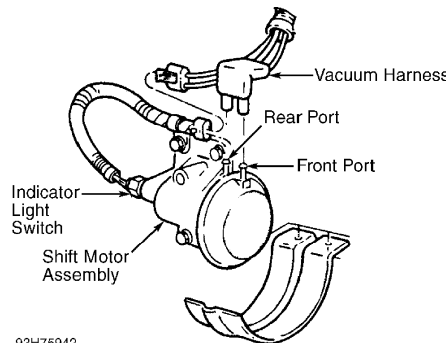
### FRONT AXLE SHIFT MOTOR

1) Raise and support vehicle. Remove vacuum harness from front axle shift motor. Apply 15 in. Hg to front port of shift motor. See Fig. 2. Rotate left front wheel to disengage axle (2WD operation).

2) Replace shift motor if it does not hold vacuum for at least 30 seconds. If shift motor holds vacuum, disconnect vacuum pump from front port, Connect vacuum pump to shift motor rear port. See Fig. 2. Apply 15 in. Hg to shift motor.

3) Replace shift motor if it does not hold vacuum for at least 30 seconds. While vacuum is applied to shift motor rear port, rotate left front wheel to ensure axle shafts are engaged (4WD operation). If axle shafts are engaged, shift motor and linkage are okay.

4) Indicator light switch is a mechanically mounted in shift motor housing. Axles must be completely engaged for shift motor shaft to actuate switch. If 4WD operation is engaged and indicator light on instrument panel illuminates, shift motor is operating properly. If not, check indicator light switch and bulb.



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Fig. 2: Removing Shift Motor & Housing  
Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

## AXLE SHIFT MOTOR & HOUSING

### Removal

1) Raise and support vehicle. Place a drain pan under shift assembly. Disconnect vacuum harness. Disconnect indicator light switch harness. Remove mounting bolts. Remove the shift motor assembly. See Fig. 2.

2) Mark shift fork and housing for reassembly. Remove shift fork and motor snap rings. Remove shift motor from housing.

### Installation

Install NEW "O" ring on motor shaft. Assemble shift motor shift fork onto shaft. Position motor and housing on axle. Add axle oil to shift motor housing. Install shift fork in shift collar and install mounting bolts. Connect vacuum harnesses. Connect indicator light switch harness.

## M - VACUUM DIAGRAMS

1993 Jeep Cherokee

1993 ENGINE PERFORMANCE  
Chrysler Corp. Vacuum Diagrams

Jeep; Cherokee, Grand Wagoneer, Grand Cherokee, Wrangler

### INTRODUCTION

This article contains underhood views of vacuum hose routing. Use these vacuum diagrams during the visual inspection portion of F - BASIC TESTING article in the ENGINE PERFORMANCE Section. This will assist in identifying improperly routed vacuum hoses which may cause driveability and/or computer-indicated malfunctions.

NOTE: Always refer to Emission Control Label in engine compartment before attempting service. If specifications in manual differ from label, always use emission label specifications.

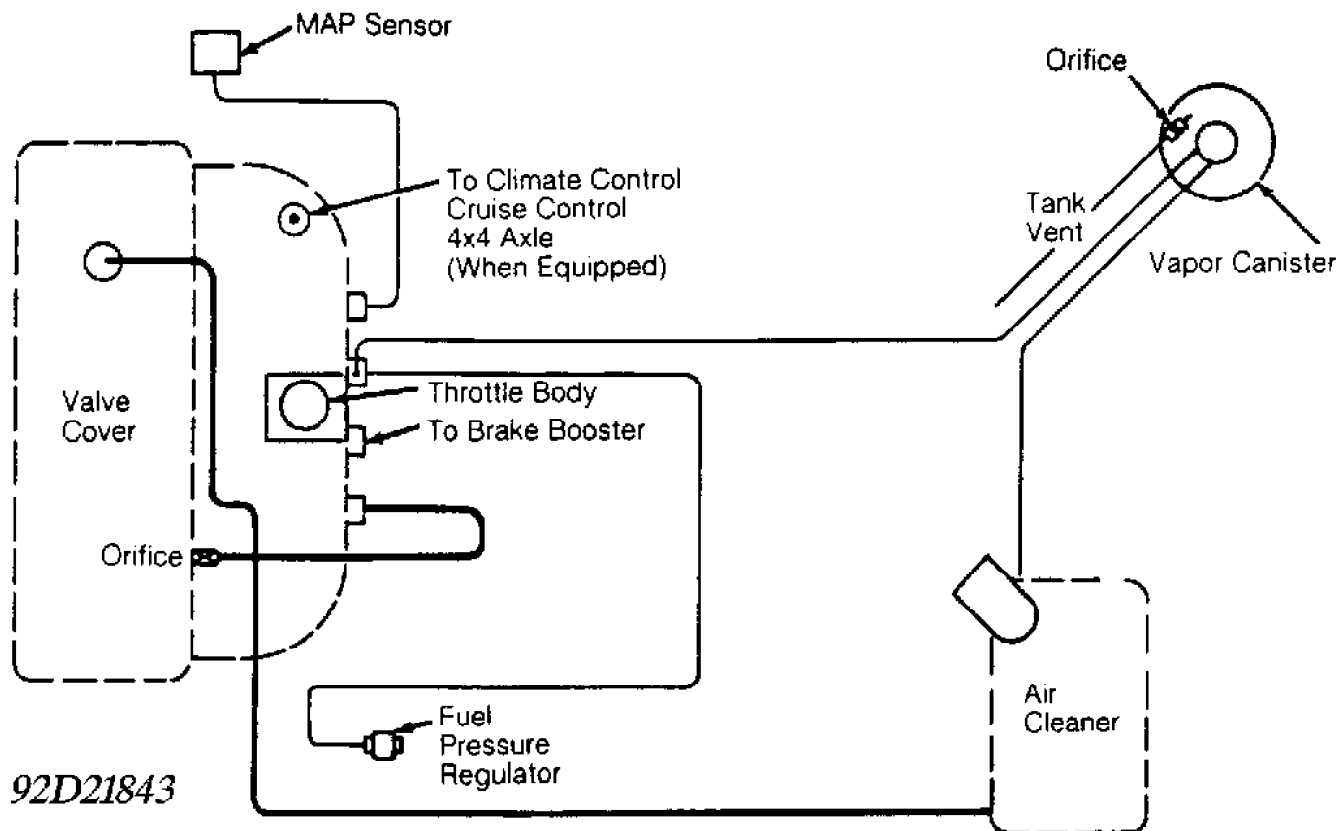


Fig. 1: Engine Vacuum Diagram (2.5L)  
Courtesy of Chrysler Corp.

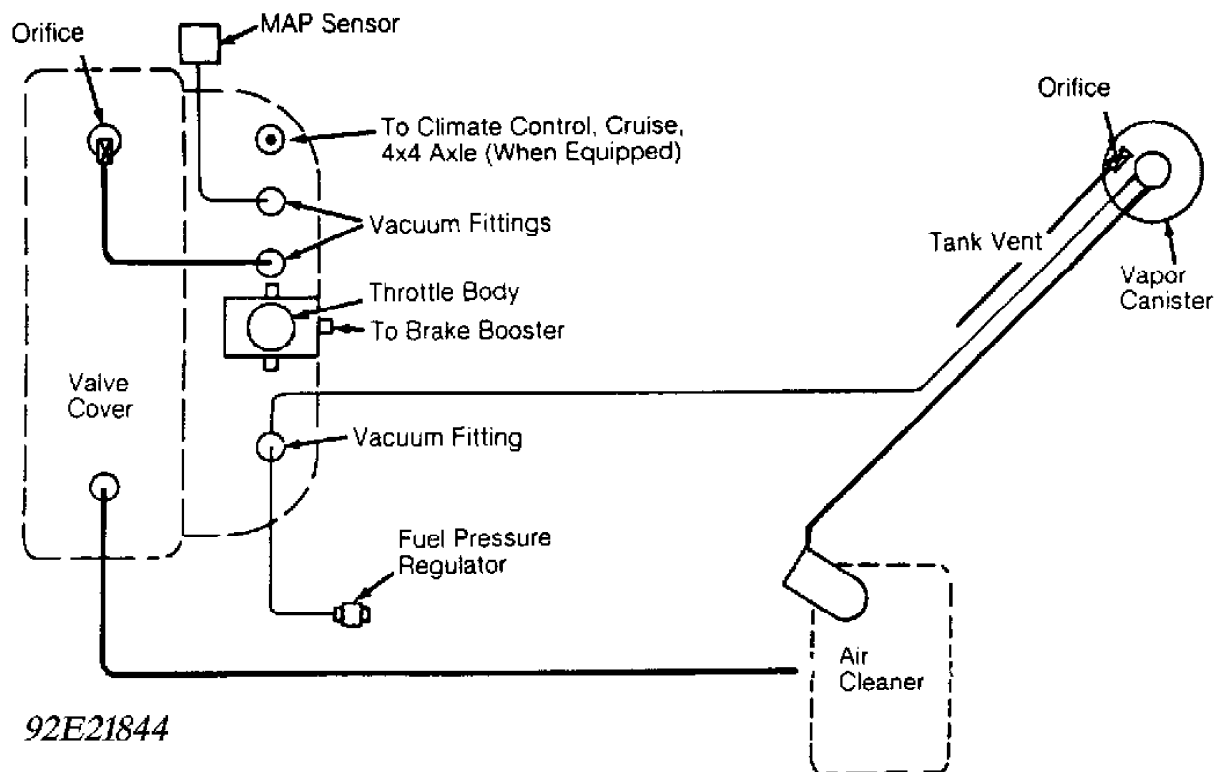


Fig. 2: Engine Vacuum Diagram (4.0L)  
Courtesy of Chrysler Corp.

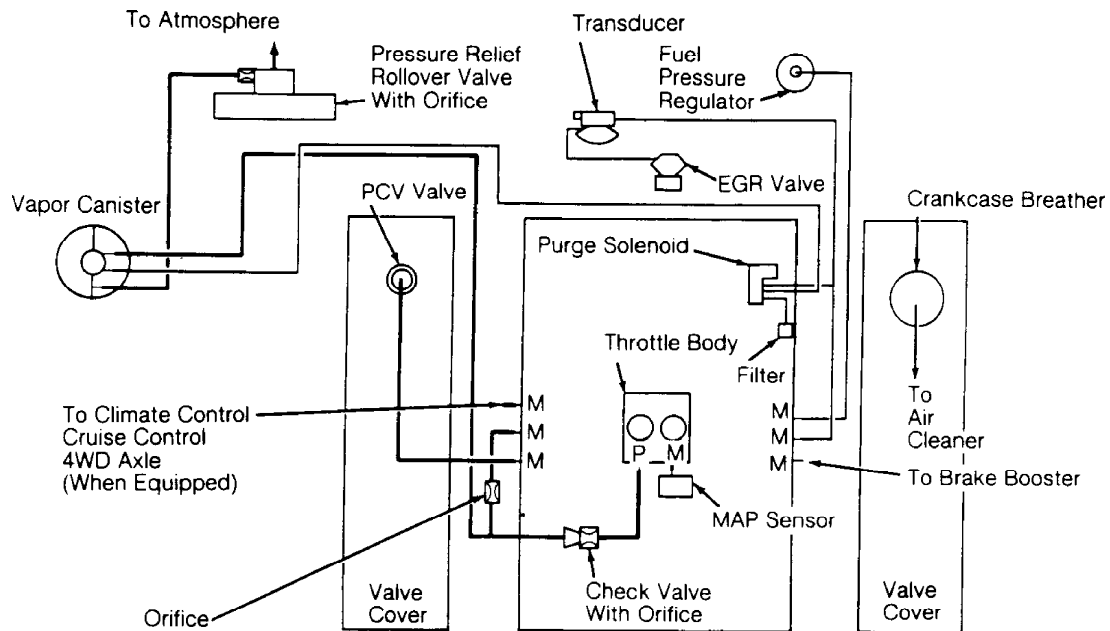


Fig. 3: Engine Vacuum Diagram (5.2L)  
Courtesy of Chrysler Corp.

# **MAINTENANCE REMINDER LIGHT RESET PROCEDURES**

## **1993 Jeep Cherokee**

1993 MAINTENANCE  
Chrysler Motors Maintenance Reminder Lights  
Jeep; Cherokee

### **EMISSION MAINTENANCE INDICATOR LIGHT**

Vehicles are equipped with an emission maintenance indicator light on instrument cluster. This light will come on one time at 82,500 miles to alert driver that emission service is required. At this time, oxygen sensor must be replaced and all other emission components should be inspected and serviced or replaced as necessary. Chrysler's Diagnostic Readout Box (DRB-II) tester is required to reset the emission maintenance indicator light.

### **RESET PROCEDURE**

Using DRB-II tester, access SELECT SYSTEMS. Select appropriate engine. Select with or without A/C. Select FUEL & IGNITION. Select ADJUSTMENTS. Select RESET EMR LIGHT. Reset EMR light. When DRB-II is finished resetting light, DRB-II display will read EMR LIGHT IS RESET.

# MAINTENANCE INFORMATION

## 1993 Jeep Cherokee

1989-95 MAINTENANCE  
Jeep Maintenance Information

Cherokee,  
Wagoneer (1989-90)

### \* PLEASE READ THIS FIRST \*

NOTE: For scheduled maintenance intervals and the related fluid capacities, fluid specifications and labor times for major service intervals, see SCHEDULED SERVICES article. Warranty information and specifications for fluid capacities, lubrication specifications, wheel and tire size, and battery type are covered in this article.

### MODEL IDENTIFICATION

#### VIN LOCATION

The Vehicle Identification Number (VIN) is located on the left side of the dash panel at the base of the windshield. The VIN chart explains the code characters.

#### VIN CODE ID EXPLANATION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label. See VIN example below.

(VIN)	1	J	C	U	N	7	7	1	X	G	T	0	0	0	0	0	1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

1 - Manufacturing Country  
1 \* United States

2 - Company/Make  
J \* Chrysler Motors

3 - Type  
3 \* MPV (1989-92)  
4 \* MPV (1993-96)  
6 \* Incomplete  
7 \* Truck

4 - GVWR  
E \* 3001-4000  
F \* 4001-5000  
G \* 5001-6000  
H \* 6001-7000

5 - Car Line  
B \* Cherokee 2WD (RHD)  
J \* Cherokee 4X4 (LHD)  
J \* Cherokee 4X4 (RHD) EXPORT  
N \* Cherokee 4X4 (RHD) (1995-96)  
N \* Wagoneer 4WD (1989-90)



- T \* Cherokee 2WD (LHD)
- 6 - Series
  - 2 \* Base (L)
  - 2 \* SE (1995-96)
  - 3 \* Pioneer (M)
  - 5 \* Laredo (P)
  - 6 \* Sport
  - 7 \* Country
  - 7 \* Limited (X)
- 7 - Body Style
  - 5 \* 4-Door Wagon
  - 7 \* 2-Door Wagon
  - 8 \* 4-Door Wagon
- 8 - Engine
  - E \* 2.5L 4-Cylinder EFI (EPD) (1989-90)
  - L \* 4.0L I-6 MFI (ERB) (1989-90)
  - M \* 2.5L 4-Cylinder Diesel (1996 Export)
  - P \* 2.5L 4-Cylinder MFI (EPE) (1991-96)
  - S \* 4.0L I-6 HO MFI (ERH) (1991-96)
- 9 - Check Digit
  - \* Manufacturer Assigned
- 10 - Model Year
  - K \* 1989
  - L \* 1990
  - M \* 1991
  - N \* 1992
  - P \* 1993
  - R \* 1994
  - S \* 1995
  - T \* 1996
- 11 - Assembly Plant
  - L \* Toledo, Ohio, Plant No. 1
  - P \* Toledo, Ohio, Plant No 2
- 12-17 - Sequential Serial Number
  - \* Production Sequence

## **MAINTENANCE SERVICE INFORMATION**

### **SEVERE & NORMAL SERVICE DEFINITION**

NOTE: Use the Severe Service schedule if the vehicle to be serviced is operated under ANY (one or more) of these conditions:

Service is recommended at specified mileage intervals of vehicle operation. Service schedules are based on the following primary operating conditions:

#### **Severe Service**

- \* Short Trips (About 15 Miles)
- \* Cold Climate Operation
- \* Towing Or Heavily Loading
- \* Severe Dust Conditions
- \* Sustained High Speed Operation
- \* Off-Road Driving

- \* Hot Weather, Stop-And-Go Driving
- \* Extensive Idling Conditions (Taxi Or Delivery Type Service)

Normal Service

- \* Driven More Than 10 Miles Daily
- \* No Severe Service Operating Conditions

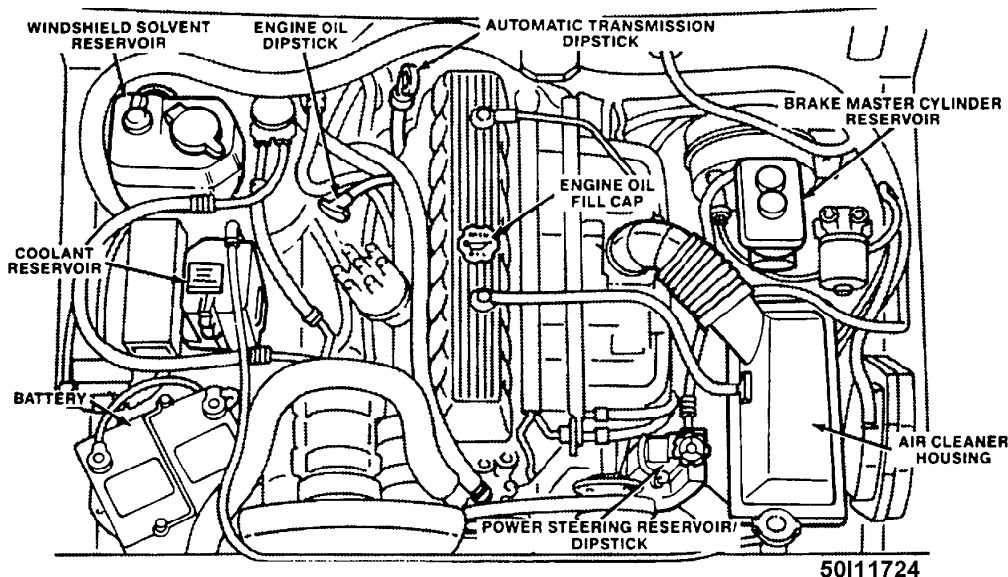
## SERVICE LABOR TIMES

SERVICE LABOR TIMES TABLE (HOURS)

Application	(1) 30,000 Mile Service	(1) 60,000 Mile Service
1989-92		
2.5L		
Automatic Transmission .....	4.2	9.3
Manual Transmission .....	2.4	7.5
4.0L		
Automatic Transmission .....	4.3	10.1
Manual Transmission .....	2.5	8.3
1993-96		
2.5L		
Automatic Transmission .....	4.2	7.6
Manual Transmission .....	2.4	5.8
4.0L		
Automatic Transmission .....	4.3	7.8
Manual Transmission .....	2.5	6.0

(1) - Add .6 hr. for vehicles equipped with 4WD.

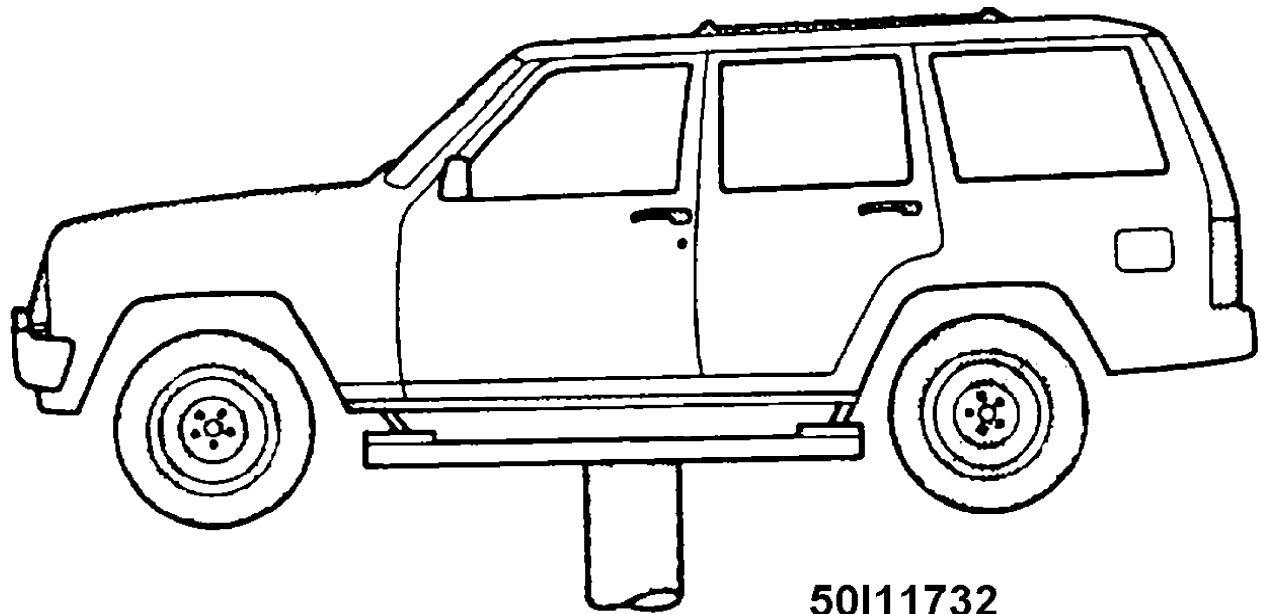
## SERVICE POINT LOCATIONS



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Fig. 1: Service Point Locations (Typical)  
Courtesy of Chrysler Corp.

## ADDITIONAL SERVICE INFORMATION



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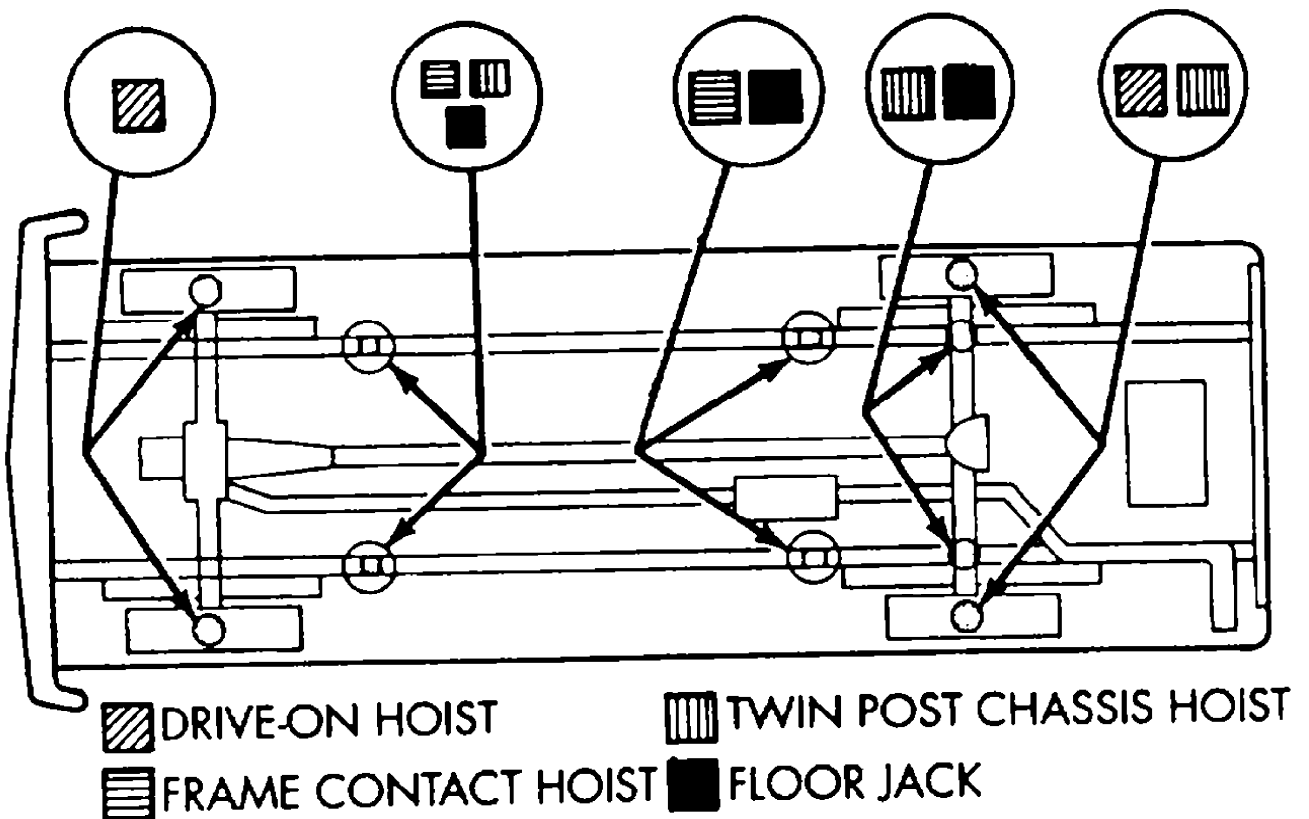
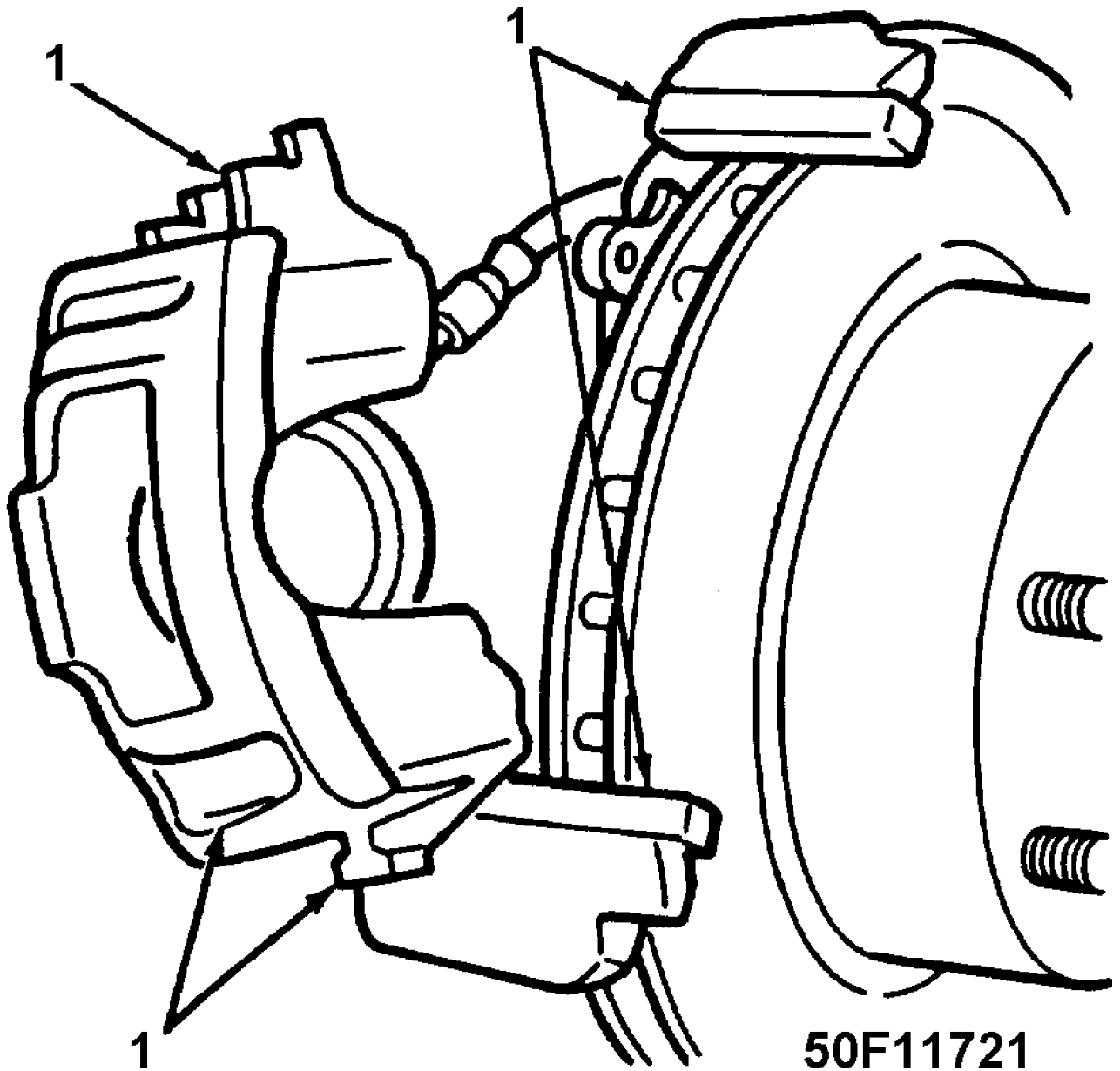


Fig. 2: Hoist Lift Point Locations  
Courtesy of Chrysler Corp.

NOTE: For more information regarding jacking and hoisting refer to the JACKING & HOISTING article in the

WHEEL ALIGNMENT section.

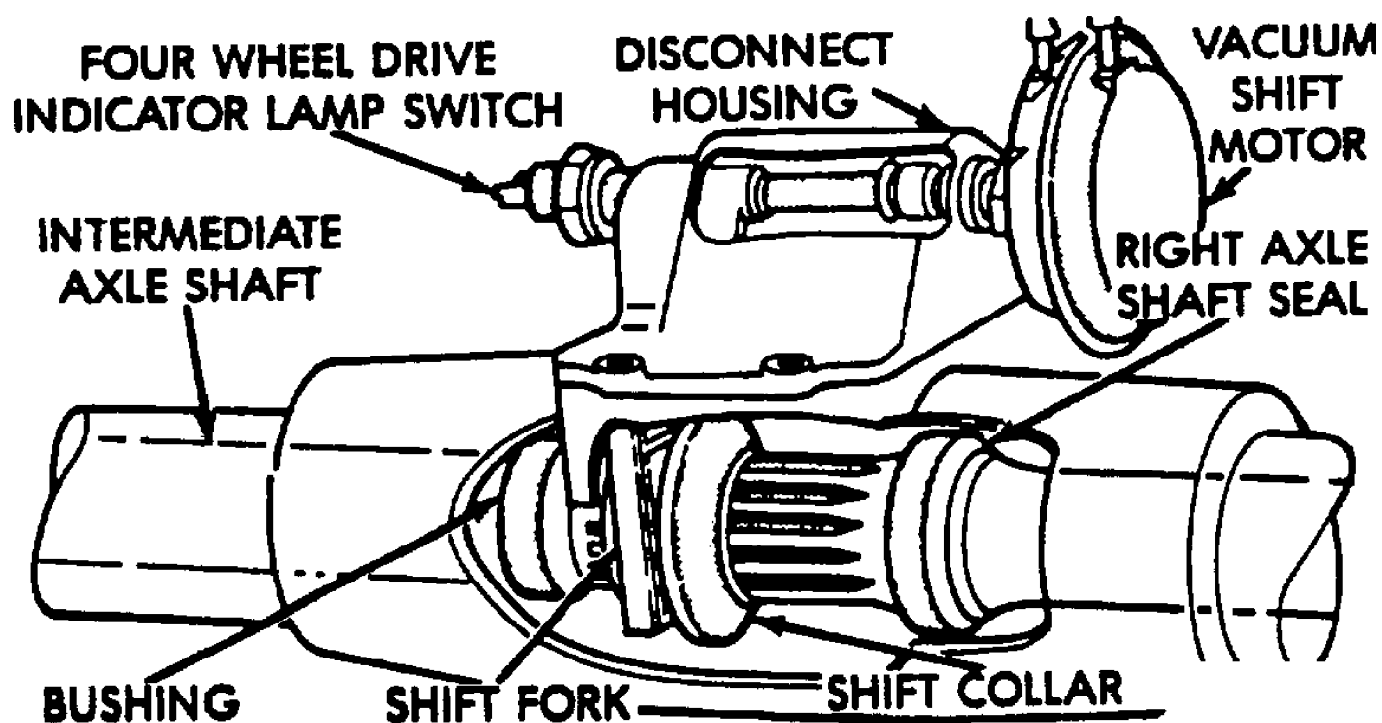


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## 1. LUBRICATION POINTS

Fig. 3: Brake Caliper Lubrication Points  
Courtesy of Chrysler Corp.

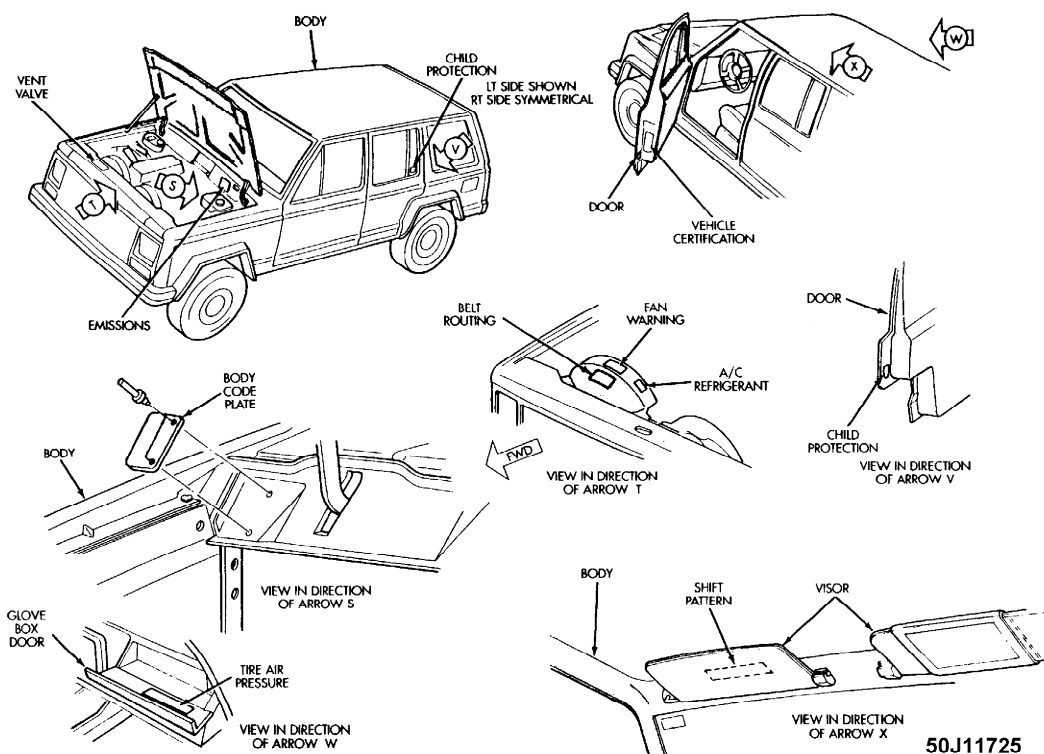
NOTE: For more information regarding brake maintenance refer to the BRAKE SYSTEM article in the BRAKES section.



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Fig. 4: Front Disconnect Housing Lubrication Point  
Courtesy of Chrysler Corp.

#### IDENTIFICATION LABEL LOCATIONS



**VEHICLE, LABELS AND PLATES**

Fig. 5: Identification Label Locations  
Courtesy of Chrysler Corp.

## LUBRICATION SPECIFICATIONS

### LUBRICATION SPECIFICATIONS TABLE

Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-III/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperature Range	
Above 0° F (-18°C)	SAE 10W-30 API SH/CD ECII
Less Than 60° F (16°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIIE ATF
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB

Weatherstrip ..... Silicone Spray Lubricant

- (1) - DO NOT use Dexron-III ATF, Clutch chatter can result.
  - (2) - SAE 10W-30 SH/CD ECII is preferred.
  - (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
  - (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
  - (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
  - (6) - Use low pressure grease gun to prevent seal damage.
  - (7) - Fill until lubricant squeezes out from the base of seals.
  - (8) - Fill ball joint until seal starts to swell.
- 

## FLUID CAPACITIES

### FLUID CAPACITIES TABLE

Application	Quantity (1)
A/C System R-12 Refrigerant Capacity	
1989-90 .....	36-40 Ozs.
1991-93	
Cherokee 2-Door .....	32 Ozs.
Cherokee 4-Door .....	38 Ozs.
1994 (up to 12/93)	
Cherokee 2-Door .....	32 Ozs.
Cherokee 4-Door .....	38 Ozs.
A/C System R-134a Refrigerant Capacity (2)	
1994-96 (from 1/94) .....	32 Ozs.
Automatic Transmission (3)	
30RH (3-Speed)	
Fluid Change .....	4.0 Qts. (3.8L)
Overhaul (Dry Fill) .....	8.75 Qts. (8.2L)
AW4 (4-Speed)	
Fluid Change .....	2.0 Qts. (1.7L)
Overhaul (Dry Fill) .....	8.5 Qts. (8.0L)
Cooling System	
2.5L (4) .....	10.0 Qts. (9.5L)
4.0L (5) .....	12.0 Qts. (11.4L)
Engine Oil (6)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
Fuel Tank .....	20.2 Gals. (76.4L)
Manual Transmission (7)	
AX4 (4-Speed AISIN) .....	7.4 Pts. (3.5L)
T4 (4-Speed Borg-Warner) .....	3.9 Pts. (1.8L)
AX5 (5-Speed AISIN)	
2.5L (2WD) .....	7.0 Pts. (3.5L)
2.5L (4X4) .....	6.6 Pts. (3.2L)
T5 (5-Speed Borg-Warner) .....	4.5 Pts. (2.1L)
AX15 (5-Speed AISIN)	
4.0L (2WD) .....	6.4 Pts. (3.1L)
4.0L (4X4) .....	6.5 Pts. (3.15L)
Transfer Case	
Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)
Drive Axles (7)	

Front Axle (Model 30)		
Command-Trac (Disconnect)	.....	3.76 Pts. (1.65L)
(Disconnect Housing) (8)	.....	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect)	.....	3.13 Pts. (1.5L)
Rear Axle		
1989-94 (9)	.....	2.5 Pts. (1.2L)
1995-96		
Model 35 (9)	.....	3.5 Pts. (1.6L)
8-1/4" (9)	.....	4.4 Pts. (2.1L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Use of R-12 in a R-134a system will result in SEVERE DAMAGE
- (3) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.
- (4) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (5) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (6) - Includes Filter.
- (7) - Fill to bottom edge of filler plug hole.
- (8) - Add 5 ozs. of gear lubricant through indicator switch hole.
- (9) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.

WHEEL & TIRE SPECIFICATIONS

WHEEL & TIRE SPECIFICATIONS TABLE

Wheel Size	Tire Size
Cherokee	
15x6 & 15x7 (Aluminum Or Steel)	P195/75R15
15x6 & 15x7 (Aluminum Or Steel)	P205/75R15
15x6 & 15x7 (Aluminum Or Steel)	P215/75R15
15x6 & 15x7 (Aluminum Or Steel)	P225/75R15
Wagoneer	
15x6 (Aluminum/Steel)	P205/75R15
All Models	
16-Inch Wheels	Compact Spare Tire

TIRE REPLACEMENT

CAUTION: Always ensure all 4 tires on the vehicle are the same size, except when using the temporary spare. The use of mismatched tires may cause unpredictable handling. Replacing original tires with tires of a different size may result in false speedometer and odometer indications.

TIRE INFLATION

The tire specification decal is located in the glove box.

WHEEL TIGHTENING

Tighten the lug nuts firmly in a crisscross pattern as shown in Fig. 6. Tighten per following specifications. Always position wheel locking nut opposite valve stem in position indicated. See Fig. 6.

1989-92  
Tighten lug nuts in crisscross pattern to 80-110 ft. lbs. (109-150 N.m).



1993

Tighten lug nuts in crisscross pattern to 95 ft. lbs. (129 N.

m).

1994-96

Tighten lug nuts in crisscross pattern to 85-110 ft. lbs.

(115-149 N.m).

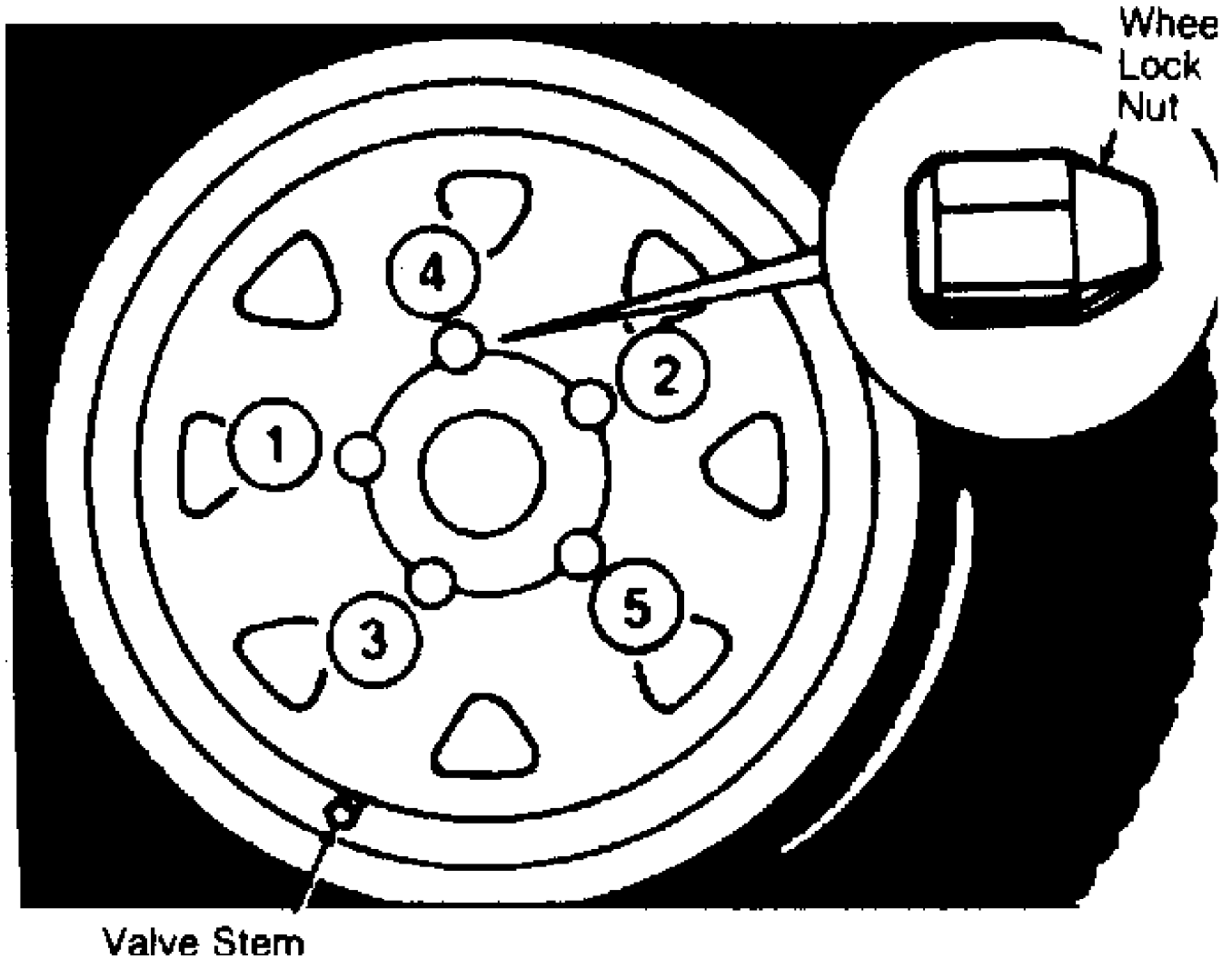


Fig. 6: Wheel Locking Nut Location  
Courtesy of Chrysler Corp.

## BATTERY SPECIFICATIONS

**CAUTION:** When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section.

All gasoline engine equipped models use BCI group 58 batteries with 390 to 500 Cold Cranking Amp rating.

## **CAUTIONS & WARNINGS**

### **SUPPLEMENTAL RESTRAINT SYSTEM (SRS) AIR BAG SYSTEM**

**NOTE:** See the AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT Section.

The SRS has no user-servicable parts. Always have servicing done by an authorized dealer.

When performing maintenance on air bag equipped vehicles always observe proper safety precautions.

**WARNING:** To avoid injury from accidental air bag deployment, read and carefully follow all warnings and service precautions. See appropriate AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

**CAUTION:** Disconnect negative battery cable before servicing any air bag system, steering column or passenger side dash component. After any repair, turn ignition key to the ON position from passenger's side of vehicle in case of accidental air bag inflation

### **ANTI-LOCK BRAKE SYSTEM (ABS)**

**CAUTION:** Never mix different diameter tires. On loose or uneven surfaces, the ABS system may require longer stopping distances than conventional brake systems. Exercise caution when removing mud or snow from the wheels so as not to damage the ABS wiring or speed sensors.

### **BATTERY WARNING**

**WARNING:** When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See appropriate COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section below.

### **REPLACING BLOWN FUSES**

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

### **BRAKE PAD WEAR INDICATOR**

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

### **CATALYTIC CONVERTER**

Continued operation of vehicle with a severe malfunction could cause converter to overheat, resulting in possible damage to converter and vehicle.

## COOLANT (PROPYLENE-GLYCOL FORMULATIONS)

CAUTION: To avoid possible damage to vehicle use only ethylene-glycol based coolants with a mixture ratio from 44-68% anti-freeze. DO NOT use 100% anti-freeze as it will cause the formation of cooling system deposits. This results in coolant temperatures of over 300° F (149°C) which can melt plastics. 100% anti-freeze has a freeze point of only -8° F (-22°C).

CAUTION: Propylene-Glycol Mixtures has a smaller temperature range than Ethylene-Glycol. The temperature range (freeze-boil) of a 50/50 Anti-Freeze/Water Mix is as follows:

Propylene-Glycol	-26° F (-32°C)	-	257° F (125°C)
Ethylene-Glycol	-35° F (-37°C)	-	263° F (128°C)

CAUTION: Propylene-Glycol/Ethylene-Glycol Mixtures can cause the destabilization of various corrosion inhibitors. Also Propylene-Glycol/Ethylene-Glycol has a different specific gravity than Ethylene-Glycol coolant, which will result in inaccurate freeze point calculations.

## ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

## ENGINE OIL

CAUTION: Never use non-detergent or straight mineral oil.

## FUEL SYSTEM SERVICE

WARNING: Relieve fuel system pressure prior to servicing any fuel system component (fuel injection models).

## HALOGEN BULBS

WARNING: Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

## RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

## RADIATOR FAN

WARNING: Keep hands away from radiator fan. Fan is controlled by a thermostatic switch which may come on or run for up to 15 minutes even after engine is turned off.

## AXLE FLUID

CAUTION: Axle lubricant should be changed whenever the axle has

been submerged in water. Water can enter through the axle vent hole and contaminate the lubricant.

## **COMMAND-TRAC (4WD)**

CAUTION: NEVER operate a Command-Trac vehicle in 4WD on dry, hard-surfaced roads for a sustained period. Use 4L only when needed for added pulling power. Operating vehicle in 4WD mode on such roads will cause stress and possible damage to components, as well as make shifting difficult. To reduce shifting effort, drive vehicle in Reverse for a few feet, or drive off hard-surfaced road momentarily to allow tire slippage.

## **FRONT AND REAR DIFFERENTIALS (4WD)**

CAUTION: DO NOT use water, steam, kerosene or gasoline for flushing a differential. ONLY use a flushing oil.

## **TRAC-LOK DIFFERENTIALS (4WD)**

CAUTION: DO NOT flush a rear axle Trac-Lok differential. Trac-Lok differentials may be cleaned only by disassembling the unit and wiping the components with clean, lint-free cloth.

CAUTION: NEVER attempt to engage Low range when vehicle is moving faster than 2-3 MPH, as transfer case damage may result.

## **OIL FILTER**

CAUTION: Verify that proper Oil Filter is being used. Filters with metric threads (M20 x 1.5) must be used with some engines. Other engines use SAE type (3/4" x 16) threads, and must use an oil filter with these threads. Possible engine damage can occur with improper oil filter.

## **WHEEL & TIRE WARNINGS**

CAUTION: Replacing original tires with different size tires may result in false speedometer and odometer indications. Check with dealer before using different size tires on vehicle.

CAUTION: Ensure all 4 wheels on vehicle have same tire size, type and circumference in order to provide proper vehicle handling. DO NOT mix radial-ply with bias-ply or bias-belted tires. On 4WD vehicles, if tire size, type and circumference on all 4 wheels are not the same, gear shifting will be adversely affected and can damage transfer case.

CAUTION: Temporary-use spare tires are for emergency use only. DO NOT drive vehicle faster than 50 MPH or more than 100 miles when using spare tire. DO NOT operate vehicle in 4WD mode when using spare tire, as damage to transfer case can result. Temporary-use spare tires have a total tread life of 3,000 miles.

## **WARRANTY INFORMATION**

CAUTION: Due to the different warranties offered in various regions and the variety of after-market extended warranties

available, please refer to the warranty package that came with the vehicle to verify all warranty options.

## **BASIC NEW CAR WARRANTY**

Jeep Corporation warrants to the original purchaser that the vehicle is free from defects under normal use and service for 12 months or 12,000 miles, whichever comes first.

### **3/36 OR 7/70 CHOICE**

From 1992-94, Jeep owners may choose either 3-year/36,000 mile basic warranty coverage, or 12-month/12,000 mile basic warranty with 7-year/70,000 mile powertrain protection.

## **POWERTRAIN PROTECTION LIMITED WARRANTY**

Begins at 12 months or 12,000 miles and lasts for 7 years or 70,000 miles, whichever comes first. Warranty covers Engine, Transmission, Transfer Case, and Drive Shaft/Drive Axle(s) for RWD & 4WD.

Items not covered include, normal scheduled maintenance, tune-ups, clutch adjustments, lack of proper maintenance, and vehicles on which the mileage cannot readily be determined. A \$100.00 deductible on 2WD models and a \$150.00 deductible on 4WD models applies to each repair visit.

Powertrain Warranty also covers cost of towing to nearest Jeep Dealer if vehicle cannot be driven due to failure of a covered powertrain part.

## **ANTI-CORROSION PERFORATION WARRANTY**

Warrants the sheet metal parts of the vehicle against perforation (rust-through) due to corrosion. It covers any body sheet metal panel for unlimited mileage during the first 36 months. Outer-body sheet metal panels are covered for 7 years or 100,000 miles, whichever occurs first.

## **CUSTOMER ONE CARE WARRANTY (1995-96)**

All 1995-96 Chrysler Corporation vehicles are covered by the Customer One Care Warranty, which provides 3 year/36,000 mile coverage.

Warranty coverage can be transferred to at no cost to second owner and begins on the earlier of two start dates:

- \* Date original customer took delivery.
- \* Date vehicle was put into service (Demo).

Warranty does not cover any repair due to poor or improper maintenance. Warranty does not cover costs of damage due to use of contaminated fluids and/or the use of fluids not recommended in the vehicles owners manual.

Warranty does not cover any costs of scheduled maintenance, or the cost of worn wiper blades, worn brake pads/linings or worn clutch linings. These are normal maintenance parts that all vehicles require.

## **BASIC NEW CAR LIMITED WARRANTY (1995-96)**

Warranty covers any repairs to vehicle components (tires

excluded) which have proven defective in material and workmanship during normal use. Warranty repairs (parts and labor) will be made by the dealer at no charge. Beginning at warranty start date, warranty lasts for 36 months or 36,000 miles, whichever occurs first.

Warranty covers every Chrysler supplied part of vehicle EXCEPT its tires and OKI cellular telephone (Tires and Telephone are covered by separate warranties offered by their manufacturers).

Under the 36-month/36,000-mile warranty, the following items are only warranted for the first 12 months or 12,000 miles, whichever occurs first:

- \* Brakes (Rotors, Pads, Linings & Drums)
- \* Wiper Blades
- \* Clutch Discs

#### **EMISSION DEFECT WARRANTY (EXCEPT CALIFORNIA)**

It warrants that vehicle meets Federal emissions standards in force at time of vehicle's manufacture. Warranty covers the cost of repair or adjustment of any parts of vehicle's emission control systems that are defective in material, workmanship or factory preparation, but ONLY IF the defect causes the vehicle to fail to meet Federal standards. Begins at warranty start date and lasts for 5 years or 50,000 miles, whichever occurs first.

#### **EMISSION PERFORMANCE WARRANTY (EXCEPT CALIFORNIA)**

It begins at warranty start date and lasts for 5 years or 50,000 miles, whichever comes first. This warranty applies only under the following conditions:

- \* Vehicle failed a Federally-approved state or local emissions test.
- \* Vehicle has been maintained and operated properly up until the time of testing.
- \* Owner faces a penalty or other sanctions because of the vehicle's failure to pass the local emissions test.

The following components and systems are covered: Carburetor Feedback Control System, Electronic Fuel Injection System, Air Cleaner Vapor Containment Door System, Electronic Spark Control, Electronic Control Module, Vapor Storage Canister and Controls, Deceleration Throttle Control, EGR Valve & Control System, Air Pump, Belt & Pulley, Air Injection Controls, PCV Valve, Catalytic Converter, Vacuum Hoses, Clamps, Fittings & Tubing used in these components and systems, Vacuum, Temperature, Altitude, Speed and Time-Sensitive Valves and Switches used in these components and systems.

#### **EMISSION PERFORMANCE WARRANTY (CALIFORNIA)**

If vehicle fails a Smog Check inspection, all necessary repairs and adjustments will be made by manufacturer to ensure that your vehicle passes the inspection. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

#### **EMISSION DEFECTS WARRANTY (CALIFORNIA)**

If any emission-related part on your vehicle is defective, the part will be repaired or replaced by manufacturer for a period of

3 years or 50,000 miles, whichever occurs first. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

The following emission-related parts are warranted for 7 years or 70,000 miles, whichever occurs first, and will be repaired or replaced by manufacturer if found to be defective in material or workmanship: Catalytic Converter, Intake Manifold, Carburetor, Throttle Body, Injectors, Fuel Tank, Exhaust Manifolds (4.0L).

### ROADSIDE ASSISTANCE (1995-96)

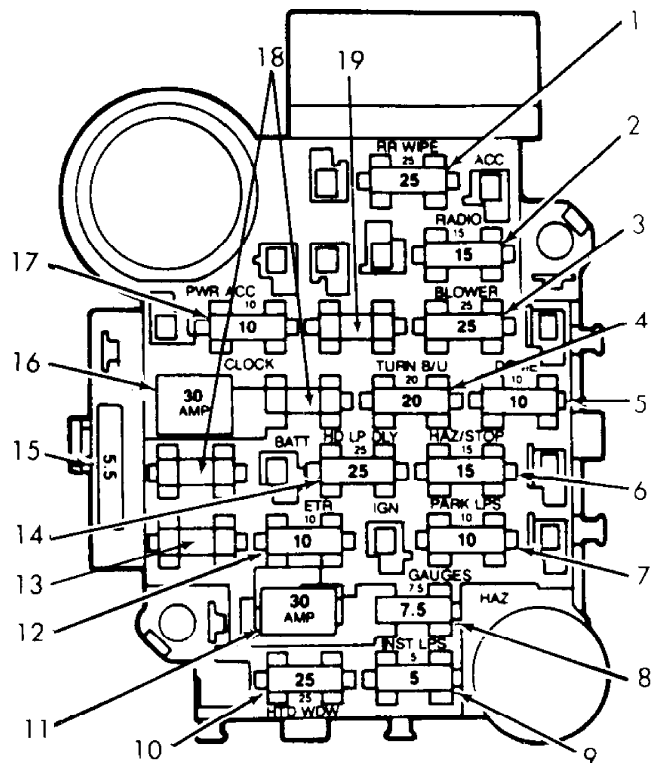
Included in the Customer One Care Warranty is 24 Hour Roadside Assistance coverage, which provides the following services:

- \* Flat Tire Service
- \* Out of Gas
- \* Battery Jump Assistance
- \* Lockout Service
- \* Towing Service

NOTE: 24 Hour Roadside Assistance phone number is 800-521-2779

### FUSES & CIRCUIT BREAKERS

Fuse panel is located at the lower left side of dash on most models.

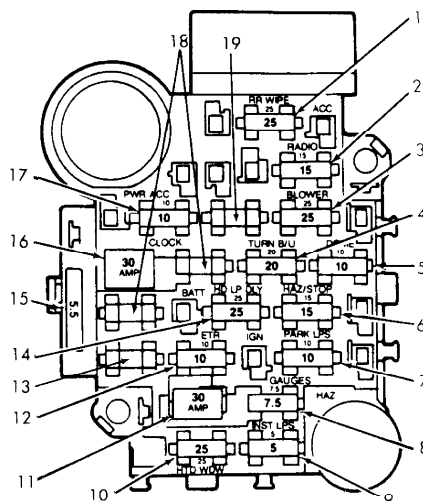


93C44570

Fig. 7: Fuse Panel Identification (1989-90 Models)  
Courtesy of Chrysler Corp.

Fuse & Circuit Breaker Identification

- 1 - 25 Amp (Natural)  
Rear Washer/Wiper
- 2 - 15 Amp (Blue)  
Radio, Cigarette Lighter
- 3 - 25 Amp (Natural)  
Blower Motor
- 4 - 20 Amp (Yellow)  
Turn Signal, Back-Up Lights, Rear Window Defogger Relay
- 5 - 10 Amp (Red)  
Dome Light, Courtesy Lights, Glove Box Light, Cargo Light,  
Radio & Clock Memories, Power Mirrors, Teltak Connector  
Headlight Delay, Chime Module, Overhead Console
- 6 - 15 Amp (Blue)  
Hazard Warning System, Stoplights
- 7 - 10 Amp (Red)  
Parking Lights, Headlamps On Warning Chime/Buzzer,  
Instrument Panel Light Dimmer
- 8 - 7.5 Amp (Violet)  
Gauges, Instrument Cluster, Seat Belt Warning
- 9 - 5 Amp (Tan)  
Instrument Panel Illumination
- 10 - 25 Amp (Natural)  
Rear Window Defogger
- 11 - 30 Amp (Circuit Breaker)  
Power Door Locks, Power Seats, Trailer Towing Wiring Harness
- 12 - 10 Amp (Red)  
ETR Radio, Power Antenna
- 13 - 7.5 Amp (Violet)  
Transmission Control Unit
- 14 - 25 Amp (Natural)  
Headlight Delay
- 15 - 4.8 Amp (Circuit Breaker)  
Front Wiper
- 16 - 30 Amp (Circuit Breaker)  
Power Windows
- 17 - 10 Amp (Red)  
Clock
- 18 - 2 Amp (Gray)  
Anti-Lock Brake System
- 19 - 15 Amp (Blue)  
Flash-to-Pass



93C44570

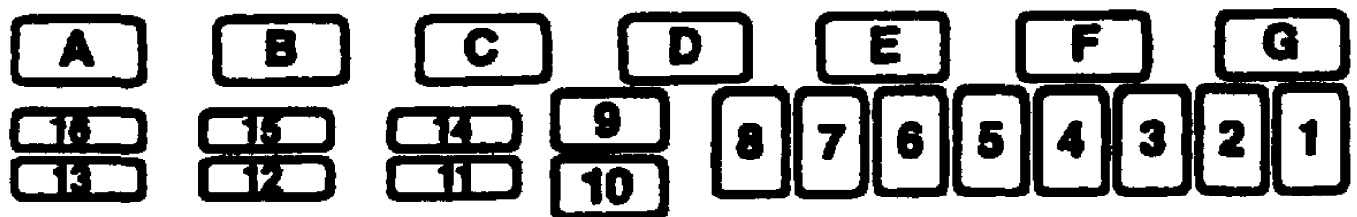
Fig. 8: Fuse Panel Identification (1991 Models)  
Courtesy of Chrysler Corp.



## Fuse & Circuit Breaker Identification

- 1 - 25 Amp (Natural)  
Rear Washer/Wiper
- 2 - 15 Amp (Blue)  
Radio, Cigarette Lighter, Illumination Relay (Clock)
- 3 - 25 Amp (Natural)  
Blower Motor
- 4 - 20 Amp (Yellow)  
Turn Signal, Back-Up Lights, Rear Window Defogger Relay
- 5 - 10 Amp (Red)  
Dome Light, Courtesy Lights, Glove Box Light, Cargo Light,  
Radio Memory, Power Mirrors, Teltak Connector
- 6 - 15 Amp (Blue)  
Hazard Warning System, Stoplights
- 7 - 10 Amp (Red)  
Parking Lights, Headlight Warning Chime/Buzzer, Instrument  
Panel Light Dimmer
- 8 - 7.5 Amp (Violet)  
Gauges, Instrument Cluster, Seat Belt Warning,
- 9 - 5 Amp (Tan)  
Instrument Panel Illumination
- 10 - 25 Amp (Natural)  
Rear Window Defogger
- 11 - 30 Amp (Circuit Breaker)  
Power Door Locks, Power Seats, Trailer Towing Wiring Harness
- 12 - 10 Amp (Red)  
ETR Radio, Power Antenna
- 13 - 2 Amp (Gray)  
Anti-Lock Brake System
- 14 - 25 Amp (Natural)  
Headlight Delay, Horns, Security Alarm
- 15 - 4.8 Amp (Circuit Breaker)  
Front Wiper
- 16 - 30 Amp (Circuit Breaker)  
Power Windows
- 17 - 10 Amp (Red)  
Clock, Security Alarm (Ign)
- 18 - 2 Amp (Gray)  
Anti-Lock Brake System
- 19 - 15 Amp (Blue)  
Flash-to-Pass, Security Alarm

## UNDERHOOD POWER DISTRIBUTION CENTER IDENTIFICATION (1991)



50A11650

Fig. 9: Power Distribution Center Identification (1991)  
Courtesy of Chrysler Corp.

**WARNING:** Always disconnect battery ground cable before servicing "high-current fuses. It is recommended that "high-current" fuses be replaced by a qualified technician.

#### Fuse & Circuit Breaker Identification

- 1 - 60 Amp (Blue)  
Alternator Output
- 2 - 30 Amp (Green)  
Engine Control (ECU) - Fuel Pump, Injectors, Ignition Coil,  
Oxygen Sensors, Alternator Field, Engine Controller  
Automatic Transmission Controller (ATCU)
- 3 - 50 Amp (Red)  
Fuse Block
- 4 - Not Used
- 5 - 40 Amp (Orange)  
Headlamp Switch
- 6 - 60 Amp (Blue)  
Ignition Switch - Engine Controller, Fuel Pump Relay,  
Automatic Shutdown Relay Coil
- 7 - 40 Amp (Orange)  
Heated Rear Window, Starter Solenoid
- 8 - 30 Amp (Green)  
ABS Pump Motor
- 9 - 30 Amp (Green)  
ABS System
- 10 - 60 Amp (Blue)  
Alternator Output
- 11 - 15 Amp (Blue)  
Ignition Switch - Back-up Lamps, A/C Relay Coil,  
Shift Selector, Speed Control, Aux. Cooling Fan Relay Coil
- 12 - 15 Amp (Blue)  
Auxilliary Lamps - Fog Lamps, Underhood Lamps
- 13 - 20 Amp (Yellow)  
Auxilliary Fan
- 14 - 10 Amp (Red)  
Automatic Transmission
- 15 - 15 Amp (Blue)  
Hazard Lamps - Hazard Flasher, Brake Switch
- 16 - 2 Amp (Gray)  
ABS Battery

#### Relay Identification

- A - Radiator Fan Relay
- B - Fuel Pump Relay
- C - A/C Clutch Relay
- D - Auto Shutdown Relay
- E - Starter Relay
- F - ABS Yellow Indicator Relay
- G - ABS Modulator Relay

#### FUSE PANEL IDENTIFICATION (1992 Models)

The fuse block is to the left of the steering column, under the instrument panel.

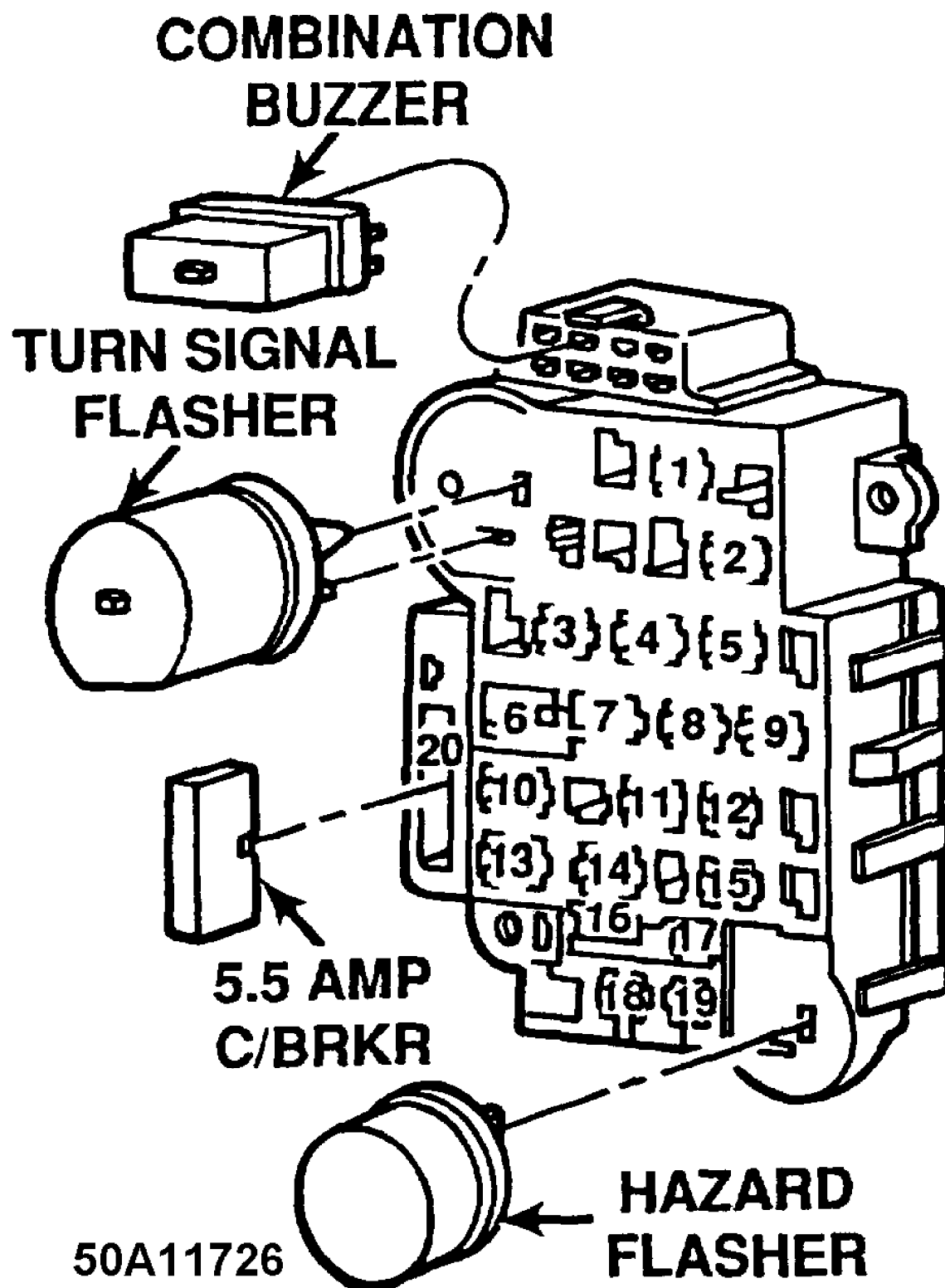
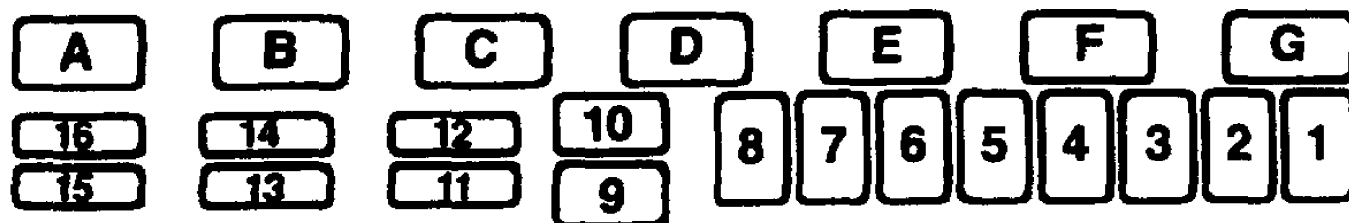


Fig. 10: Fuse Panel Identification (1992 Models)  
 Courtesy of Chrysler Corp.

- 1 - 25 Amp (Natural)  
Rear Window Wiper, Washer
- 2 - 15 Amp (Lt. Blue)  
Radio, Cigar Lighter, Dome Lamp
- 3 - 10 Amp (Red)  
Security Alarm Module
- 4 - 15 Amp (Lt. Blue)  
Headlamp Dimmer Switch, Security Alarm Module,  
Security Alarm Relay
- 5 - 25 Amp (Natural)  
Blower Motor
- 6 - 30 Amp (Circuit Breaker)  
Power Door Locks, Power Seats, Trailer Towing Wiring Harness  
Keyless Entry
- 7 - 2 Amp (Pink)  
Antilock Brakes (ABS)
- 8 - 20 Amp (Yellow)  
Turn Signal Flasher
- 9 - 10 Amp (Red)  
Radio/Clock & Memory, Courtesy Lights, Glove Box, Cargo,  
Dome Lamps, Teltak Connector, Illuminated Entry
- 10 - Not Used
- 11 - 25 Amp (Natural)  
Headlamp Delay Module, Horns, Security Alarm Module
- 12 - Not Used
- 13 - Not Used
- 14 - 10 Amp (Red)  
Power Antenna
- 15 - 15 Amp (Lt. Blue)  
Instrument Panel Lamps, Clock, Radio/Clock & Memory,  
Headlamp Switch, Parking Lamps
- 16 - 30 Amp (Circuit Breaker)  
Power Windows
- 17 - 7.5 Amp (Violet)  
Instrument Cluster Guages, Headlamp Delay Module,  
Chime Module, Overhead Console
- 18 - 25 Amp (Natural)  
Heated Rear Window
- 19 - 5 Amp (Tan)  
Instrument Panel Lamps, Radio Illumination
- 20 - 5.5 Amp (Circuit Breaker)  
Windshield Wiper/Windshield Washer

#### POWER DISTRIBUTION CENTER IDENTIFICATION (1992 Models)



**50C11652**

Fig. 11: Power Distribution Center Identification (1992 Models)  
Courtesy of Chrysler Corp.

**WARNING:** Always disconnect battery ground cable before servicing "high-current fuses. It is recommended that "high-current" fuses be replaced by a qualified technician.

Fuse & Circuit Breaker Identification

- 1 - 60 Amp (Blue)  
Alternator Output
- 2 - 30 Amp (Green)  
Engine Control (ECU) - Fuel Pump, Injectors, Ignition Coil,  
Oxygen Sensors, Alternator Field, Engine Controller  
Automatic Transmission Controller (ATCU)
- 3 - 40 Amp (Orange)  
Fuse Block
- 4 - 20 Amp (Yellow)  
Hazard Lamps
- 5 - 40 Amp (Orange)  
Headlamp Switch
- 6 - 60 Amp (Blue)  
Ignition Switch - Engine Controller, Fuel Pump Relay,  
Automatic Shutdown Relay Coil
- 7 - 40 Amp (Orange)  
Heated Rear Window, Starter Solenoid
- 8 - 40 Amp (Orange)  
ABS Pump Motor
- 9 - 60 Amp (Blue)  
Alternator Output
- 10 - 30 Amp (Green)  
ABS System
- 11 - 15 Amp (Blue)  
Ignition Switch - Back-up Lamps, A/C Relay Coil,  
Shift Selector, Speed Control, Aux. Cooling Fan Relay Coil
- 12 - 10 Amp (Red)  
Automatic Transmission
- 13 - 15 Amp (Blue)  
Auxilliary Lamps - Fog Lamps, Underhood Lamps
- 14 - 20 Amp (Yellow)  
Engine Controller
- 15 - 20 Amp (Yellow)  
Aux. Cooling Fan
- 16 - 10 Amp (Red)  
Radio Memory, Clock Memory, Ignition Off Draw

#### Relay Identification

- A - Aux. Cooling Fan Relay
- B - Fuel Pump Relay
- C - ABS Pump Relay
- D - Air Conditioning Relay
- E - Auto Shutdown Relay
- F - Starter Relay
- G - ABS System Relay

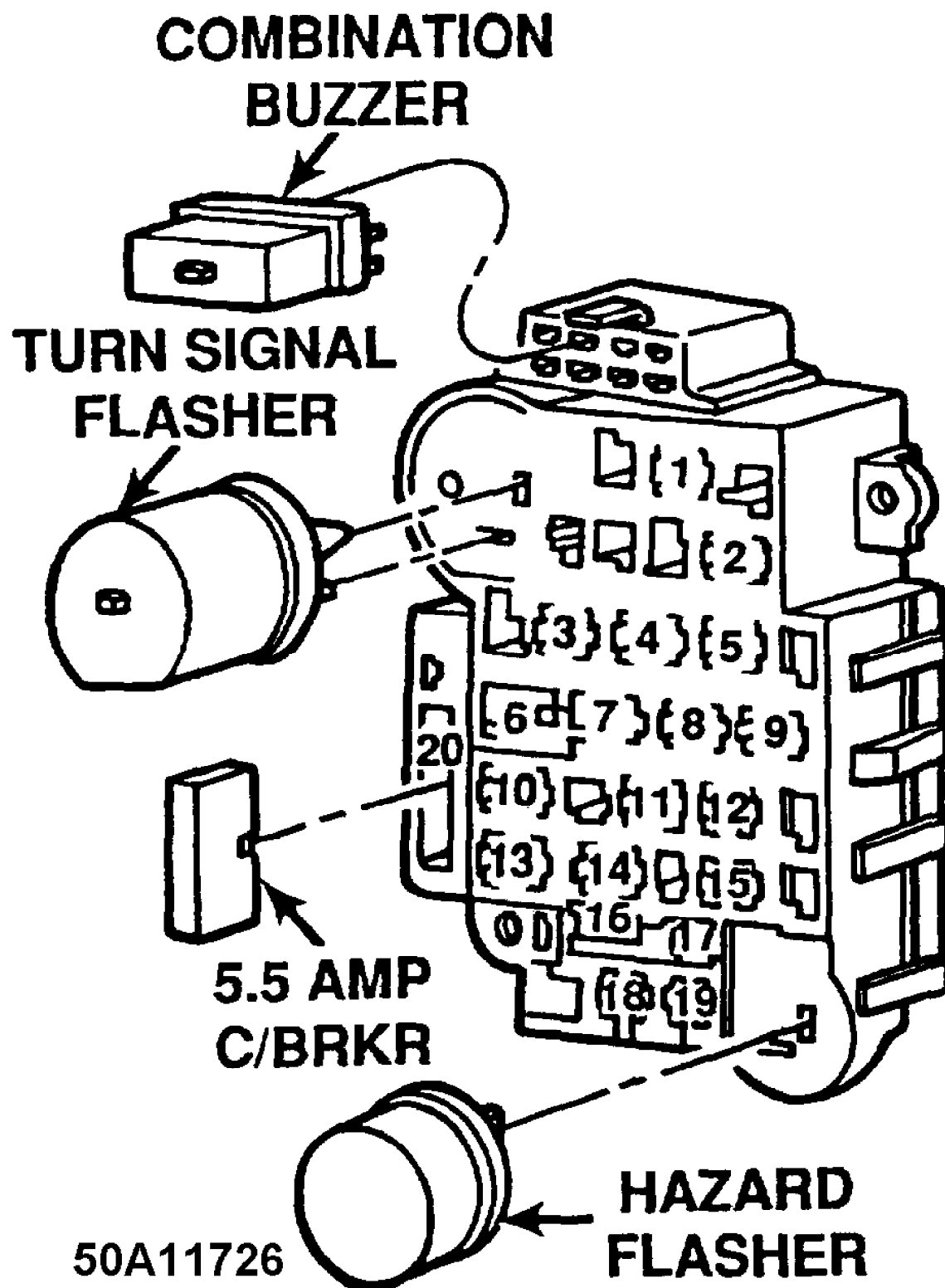


Fig. 12: Fuse Panel Identification (1993-96)  
 Courtesy of Chrysler Corp.

- 1 - 25 Amp (Natural)  
Rear Window Wiper, Washer
- 2 - 15 Amp (Lt. Blue)  
Radio, Cigar Lighter, Dome Lamp (1993)
- 3 - Not Used
- 4 - 15 Amp (Lt. Blue)  
Flash to Pass
- 5 - 25 Amp (Natural)  
Blower Motor
- 6 - 30 Amp (Circuit Breaker)  
Power Windows
- 7 - 2 Amp (Pink)  
Antilock Brakes (ABS)
- 8 - 20 Amp (Yellow)  
Turn Signal Flasher
- 9 - 10 Amp (Red)  
Radio/Clock & Memory, Courtesy Lights, Glove Box, Cargo,  
Dome Lamps, Telltales
- 10 - Not Used
- 11 - 25 Amp (Natural)  
Headlamp Delay Module, Horns
- 12 - Not Used
- 13 - 20 Amp (Yellow)  
Power Door Locks
- 14 - Not Used
- 15 - 15 Amp (Lt. Blue)  
Instrument Panel Lamps, Clock, Radio/Clock & Memory,  
Headlamp Switch, Parking Lamps
- 16 - 30 Amp (Circuit Breaker)  
Power Seats, Trailer Tow
- 17 - 7.5 Amp (Violet)  
Instrument Cluster Guages, Headlamp Delay Module,  
Chime Module, Overhead Console
- 18 - 25 Amp (Natural)  
Heated Rear Window
- 19 - 5 Amp (Tan)  
Instrument Panel Lamps, Radio Illumination
- 20 - 5.5 Amp (Circuit Breaker)  
Windshield Wiper/Windshield Washer

#### RELAY PANEL IDENTIFICATION (1993-96 MODELS)

The relay panel is to the right of the steering column, under the instrument panel.

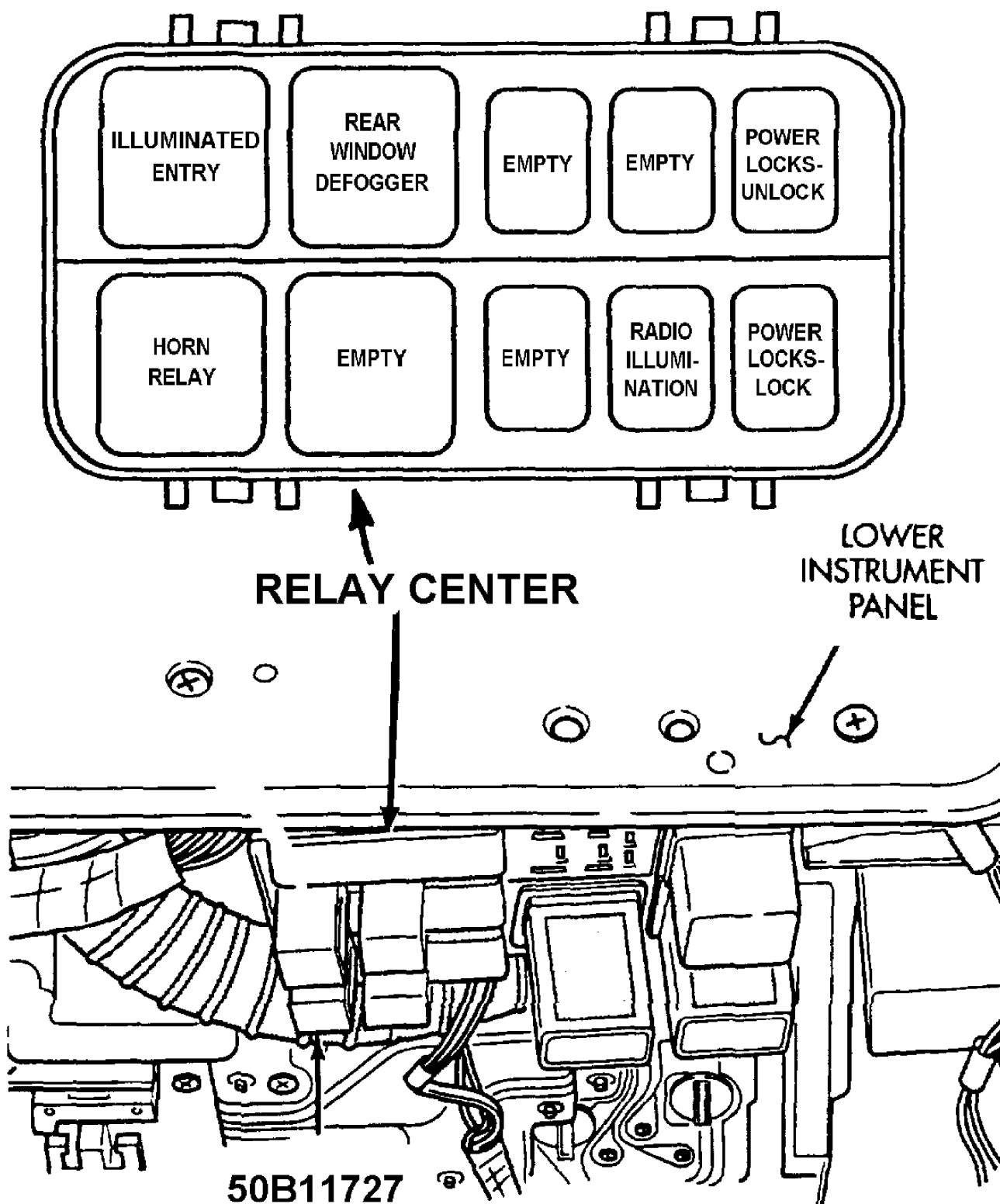


Fig. 13: Relay Block Identification (1993-96 Models)  
 Courtesy of Chrysler Corp.

Relay Identification



- 1 - Illuminated Entry Relay (1993-94)  
Not Used (1995-96)
- 2 - Horn Relay (1993-94)  
Dual Flasher Relay (1995-96)
- 3 - Rear Window Defogger Relay
- 4 - Not Used
- 5 - Not Used (1993-94)  
Horn Relay (1995-96)
- 6 - Not Used
- 7 - Not Used
- 8 - Radio Illumination Relay
- 9 - Power Door Lock (Unlock) Relay
- 10 - Power Door Lock (Lock) Relay

#### POWER DISTRIBUTION CENTER IDENTIFICATION (1993-96)

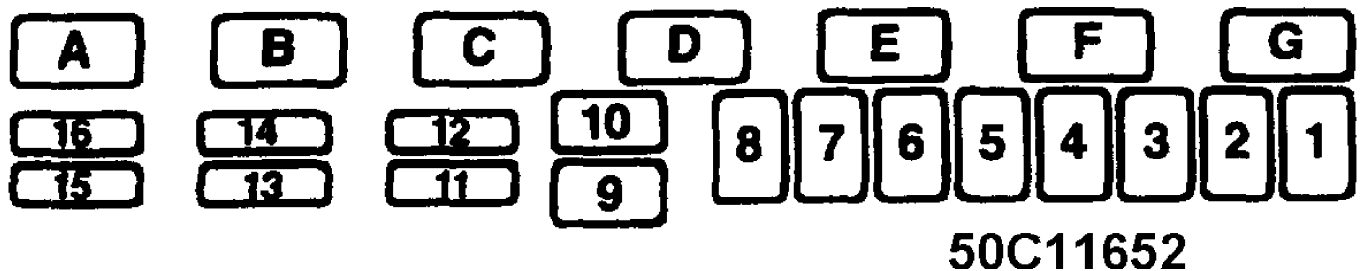


Fig. 14: Power Distribution Center Identification (1993-96)  
Courtesy of Chrysler Corp.

**WARNING:** Always disconnect battery ground cable before servicing "high-current" fuses. It is recommended that "high-current" fuses be replaced by a qualified technician.

#### Fuse & Circuit Breaker Identification

- 1 - 60 Amp (Blue)  
Generator Output
- 2 - 30 Amp (Green)  
Engine Control (ECU) - Fuel Pump, Injectors, Ignition Coil,  
Oxygen Sensors, Generator Field, Engine Controller  
Automatic Transmission Controller (ATCU)
- 3 - 40 Amp (Orange)  
Fuse Block
- 4 - 20 Amp (Yellow)  
Hazard Lamps
- 5 - 40 Amp (Orange)  
Headlamp Switch
- 6 - 50 Amp (Red)  
Ignition Switch - Engine Controller, Fuel Pump Relay,  
Automatic Shutdown Relay Coil
- 7 - 40 Amp (Orange)  
Heated Rear Window, Starter Solenoid
- 8 - 40 Amp (Orange)  
ABS Pump Motor
- 9 - 60 Amp (Blue)  
Generator Output
- 10 - 30 Amp (Green)  
ABS System
- 11 - 15 Amp (Blue)  
Ignition Switch - Back-up Lamps, A/C Relay Coil,  
Shift Selector, Speed Control, Aux. Cooling Fan Relay Coil
- 12 - 10 Amp (Red)  
Automatic Transmission

- 13 - 15 Amp (Blue)  
Auxilliary Lamps - Fog Lamps, Underhood Lamps
- 14 - 20 Amp (Yellow)  
Engine Controller
- 15 - 20 Amp (Yellow)  
Aux. Cooling Fan
- 16 - 10 Amp (Red)  
Ignition Off Draw (1993)  
Radio/Clock Memory, Ignition Off Draw, Dome Courtesy(1994-96)

Relay Identification

- A - Aux. Cooling Fan Relay
- B - Fuel Pump Relay
- C - ABS Pump Relay
- D - Air Conditioning Relay
- E - Auto Shutdown Relay
- F - Starter Relay
- G - ABS System Relay

# METRIC CONVERSIONS

## 1993 Jeep Cherokee

### GENERAL INFORMATION

### METRIC CONVERSIONS

### METRIC CONVERSIONS

Metric conversions are making life more difficult for the mechanic. In addition to doubling the number of tools required, metric-dimensioned nuts and bolts are used alongside English components in many new vehicles. The mechanic has to decide which tool to use, slowing down the job. The tool problem can be solved by trial and error, but some metric conversions aren't so simple. Converting temperature, lengths or volumes requires a calculator and conversion charts, or else a very nimble mind. Conversion charts are only part of the answer though, because they don't help you "think" metric, or "visualize" what you are converting. The following examples are intended to help you "see" metric sizes:

### LENGTH

Meters are the standard unit of length in the metric system. The smaller units are 10ths (decimeter), 100ths (centimeter), and 1000ths (millimeter) of a meter. These common examples might help you to visualize the metric units:

- \* A meter is slightly longer than a yard (about 40 inches).
- \* An aspirin tablet is about one centimeter across (.4 inches).
- \* A millimeter is about the thickness of a dime.

### VOLUME

Cubic meters and centimeters are used to measure volume, just as we normally think of cubic feet and inches. Liquid volume measurements include the liter and milliliter, like the English quarts or ounces.

- \* One teaspoon is about 4 cubic centimeters.
- \* A liter is about one quart.
- \* A liter is about 61 cubic inches.

### WEIGHT

The metric weight system is based on the gram, with the most common unit being the kilogram (1000 grams). Our comparable units are ounces and pounds:

- \* A kilogram is about 2.2 pounds.
- \* An ounce is about 28 grams.

### TORQUE

Torque is somewhat complicated. The term describes the amount of effort exerted to turn something. A chosen unit of weight or force is applied to a lever of standard length. The resulting leverage is called torque. In our standard system, we use the weight of one pound applied to a lever a foot long, resulting in the unit called a foot-pound. A smaller unit is the inch-pound (the lever is one inch long).

Metric units include the meter kilogram (lever one meter long with a kilogram of weight applied) and the Newton-meter (lever one

meter long with force of one Newton applied). Some conversions are:

- \* A meter kilogram is about 7.2 foot pounds.
- \* A foot pound is about 1.4 Newton-meters.
- \* A centimeter kilogram (cmkg) is equal to .9 inch pounds.

## PRESSURE

Pressure is another complicated measurement. Pressure is described as a force or weight applied to a given area. Our common unit is pounds per square inch. Metric units can be expressed in several ways. One is the kilogram per square centimeter ( $\text{kg}/\text{cm}^2$ ). Another unit of pressure is the Pascal (force of one Newton on an area of one square meter), which equals about 4 ounces on a square yard. Since this is a very small amount of pressure, we usually see the kiloPascal, or kPa (1000 Pascals). Another common automotive term for pressure is the bar (used by German manufacturers), which equals 10 Pascals. Thoroughly confused? Try the examples below:

- \* Atmospheric pressure at sea level is about 14.7 psi.
- \* Atmospheric pressure at sea level is about 1 bar.
- \* Atmospheric pressure at sea level is about  $1 \text{ kg}/\text{cm}^2$ .
- \* One pound per square inch is about 7 kPa.

## CONVERSION FACTORS

### CONVERSION FACTORS

TO CONVERT	TO	MULTIPLY BY
LENGTH		
Millimeters (mm)	Inches	.03937
Inches	Millimeters	25.4
Meters (M)	Feet	3.28084
Feet	Meters	.3048
Kilometers (Km)	Miles	.62137
AREA		
Square Centimeters ( $\text{cm}^2$ )	Square Inches	.155
Square Inches	Square Centimeters	6.45159
VOLUME		
Cubic Centimeters	Cubic Inches	.06103
Cubic Inches	Cubic Centimeters	16.38703
Liters	Cubic Inches	61.025
Cubic Inches	Liters	.01639
Liters	Quarts	1.05672
Quarts	Liters	.94633
Liters	Pints	2.11344
Pints	Liters	.47317
Liters	Ounces	33.81497
Ounces	Liters	.02957
WEIGHT		
Grams	Ounces	.03527
Ounces	Grams	28.34953
Kilograms	Pounds	2.20462
Pounds	Kilograms	.45359
WORK		
Centimeter Kilograms	Inch Pounds	.8676
Pounds/Sq. Inch	Kilograms/Sq. Centimeter	.07031
Bar	Pounds/Sq. Inch	14.504

Pounds/Sq. Inch	Bar	.06895
Atmosphere	Pounds/Sq. Inch	14.696
Pounds/Sq. Inch	Atmosphere	.06805
TEMPERATURE		
Centigrade Degrees	Fahrenheit Degrees	$(^{\circ}\text{C} \times 9) / 5 + 32$
Fahrenheit Degrees	Centigrade Degrees	$(^{\circ}\text{F} - 32) \times 5 / 9$

CONVERSION FACTORS (Cont.)

INCHES	DECIMALS	mm
1/64	.016	.397
1/32	.031	.794
3/64	.047	1.191
1/16	.063	1.588
5/64	.078	1.984
3/32	.094	2.381
7/64	.109	2.778
1/8	.125	3.175
9/64	.141	3.572
5/32	.156	3.969
11/64	.172	4.366
3/16	.188	4.763
13/64	.203	5.159
7/32	.219	5.556
15/64	.234	5.953
1/4	.250	6.350
17/64	.266	6.747
9/32	.281	7.144
19/64	.297	7.541
5/16	.313	7.938
21/64	.328	8.334
11/32	.344	8.731
23/64	.359	9.128
3/8	.375	9.525
25/64	.391	9.922
13/32	.406	10.319
27/64	.422	10.716
7/16	.438	11.113
29/64	.453	11.509
15/32	.469	11.906
31/64	.484	12.303
1/2	.500	12.700
33/64	.516	13.097
17/32	.531	13.494
35/64	.547	13.891
9/16	.563	14.288
37/64	.578	14.684
19/32	.594	15.081
39/64	.609	15.478
5/8	.625	15.875
41/64	.641	16.272
21/32	.656	16.669
43/64	.672	17.066
11/16	.687	17.463
45/64	.703	17.859
23/32	.719	18.256
47/64	.734	18.653
3/4	.750	19.050
49/64	.766	19.447

25/32	.....	.781	.....	19.844
51/64	.....	.797	.....	20.241
13/16	.....	.813	.....	20.638
53/64	.....	.828	.....	21.034
27/32	.....	.844	.....	21.431
55/64	.....	.859	.....	21.828
7/8	.....	.875	.....	22.225
57/64	.....	.891	.....	22.622
29/32	.....	.906	.....	23.019
59/64	.....	.922	.....	23.416
15/16	.....	.938	.....	23.813
61/64	.....	.953	.....	24.209
31/32	.....	.969	.....	24.606
63/64	.....	.984	.....	25.003
1	.....	1.000	.....	25.400

# MIRRORS - POWER

## 1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Power Mirrors

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer

### DESCRIPTION & OPERATION

#### Cherokee

Mirror control switch contains 2 separate switches: operating switch and selector switch. Each mirror has 2 reversible motors. Driver operates 3 switches that control polarity of voltage to motors. Mirror select switch directs these controlled voltages to desired mirror.

#### Grand Cherokee & Grand Wagoneer

Switches for mirror selection and operation are combined in a single assembly. Central paddle in switch assembly selects mirror to be adjusted when moved to the right or the left. Adjustment is made by pressing the buttons surrounding the central paddle. These buttons control polarity of voltage to 2 motors within each mirror which adjust mirror up, down, right and left as desired.

### TESTING

#### POWER MIRROR SWITCH

Remove power mirror switch. See POWER MIRROR SWITCH in REMOVAL & INSTALLATION. Place selector switch in right or left mirror mode. Using ohmmeter, check for resistance at appropriate terminals when each operation switch is activated. See POWER MIRROR SWITCH CONTINUITY TEST. See Figs. 1-4. If continuity is not as specified, power mirror switch must be replaced as an assembly.

#### POWER MIRROR SWITCH CONTINUITY TEST TABLE (CHEROKEE)

Switch Position	Pin Continuity
Left mirror	
Up .....	A & F, E & G
Down .....	A & G, E & F
Right .....	B & F, E & G
Left .....	B & G, E & F
Right Mirror	
Up .....	D & F, E & G
Down .....	D & G, E & F
Right .....	C & F, E & G
Left .....	C & G, E & F

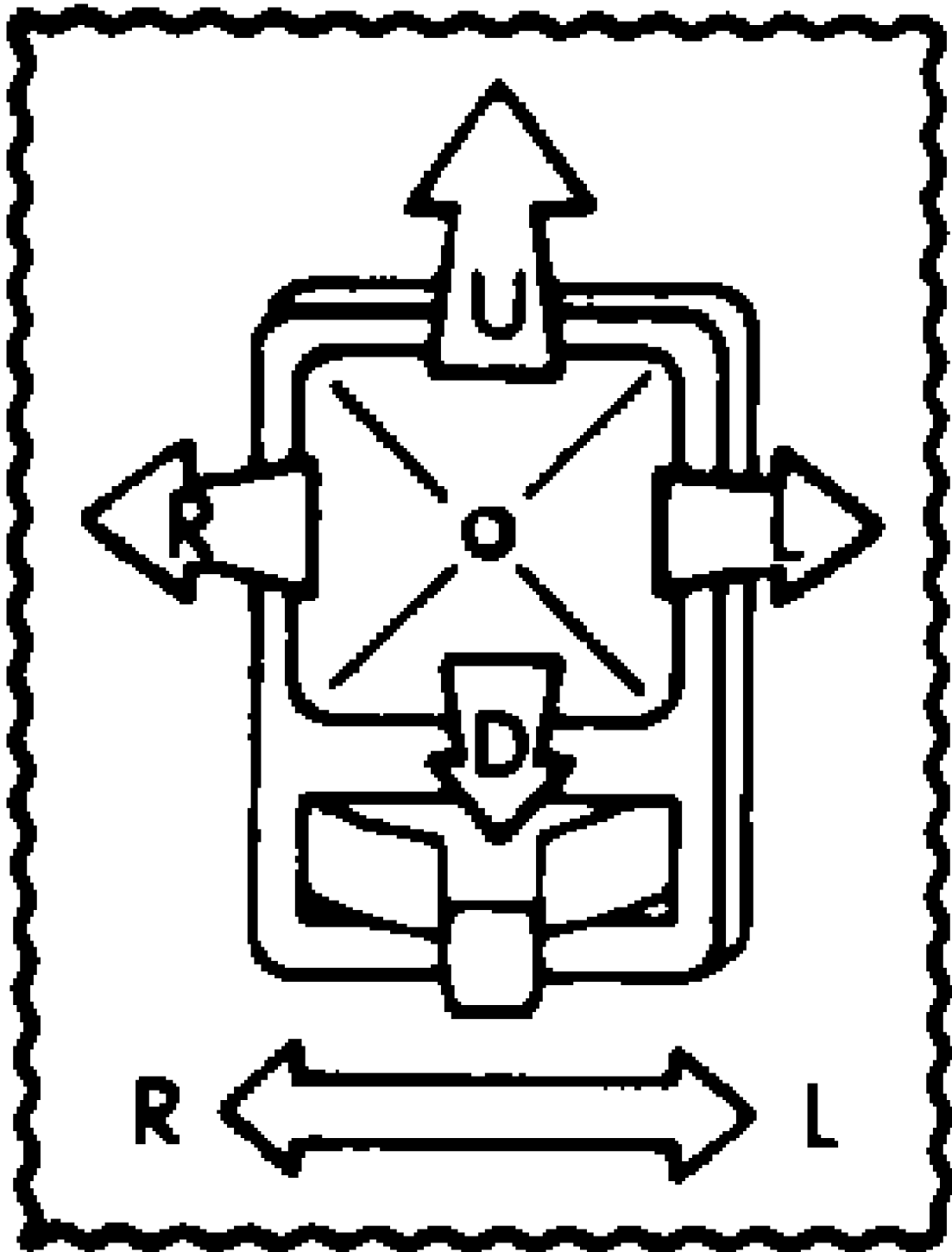
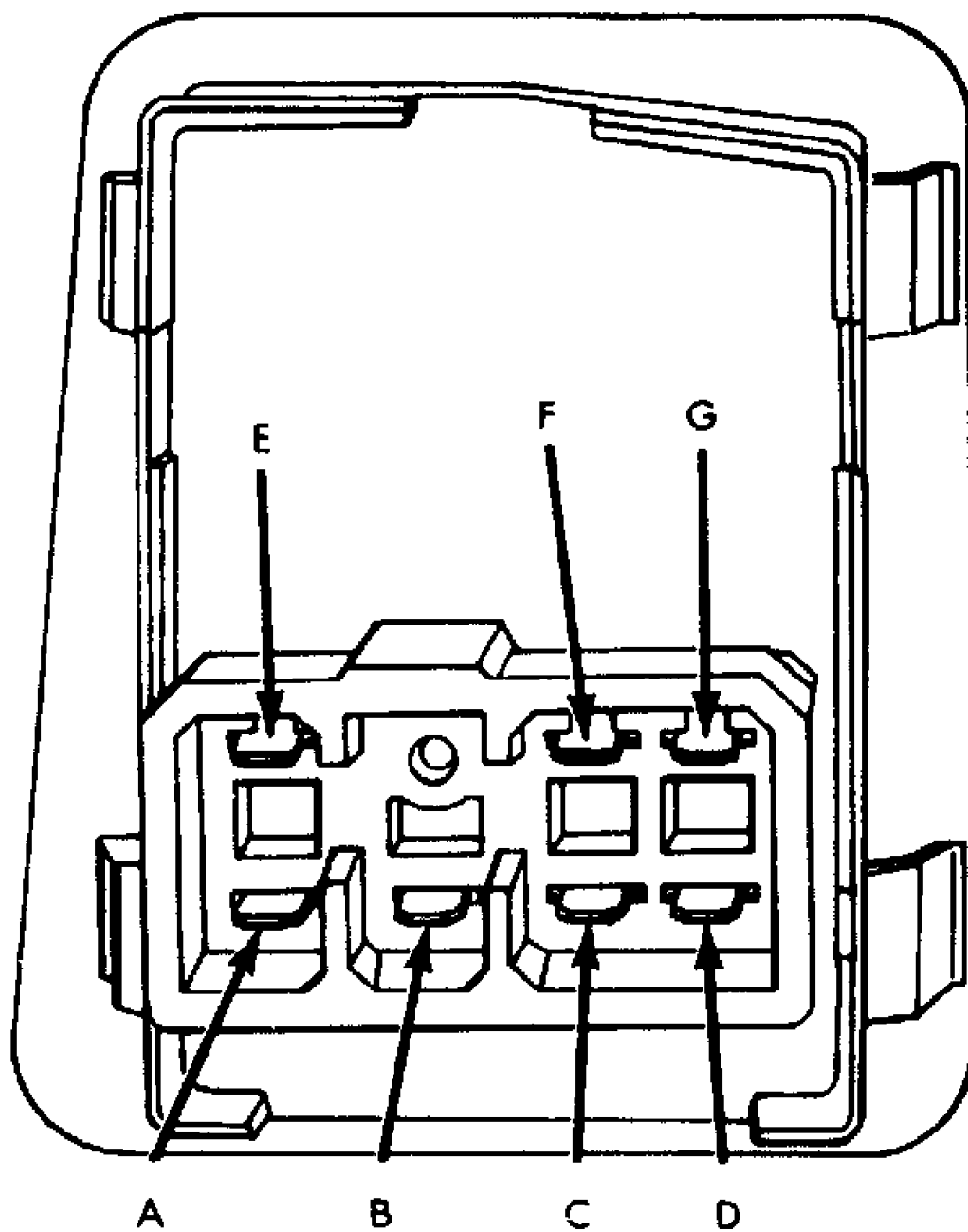


Fig. 1: Identifying Power Mirror Switch (Cherokee)  
Courtesy of Chrysler Corp.





### Power Mirror Switch Assembly

Fig. 2: Identifying Power Mirror Switch Terminals (Cherokee)  
Courtesy of Chrysler Corp.

POWER MIRROR SWITCH CONTINUITY TEST TABLE (EXCEPT CHEROKEE)

Switch Position	Pin Continuity
Left mirror	
Up .....	6 & 8; 5, 1 & 4
Down .....	6 & 1; 5 & 8
Right .....	6 & 1; 5 & 4
Left .....	6 & 4; 5, 1 & 8
Right Mirror	
Up .....	6 & 7; 5, 1 & 3
Down .....	6 & 1; 5 & 7
Right .....	6 & 1; 5 & 3
Left .....	6 & 3; 5, 1 & 7

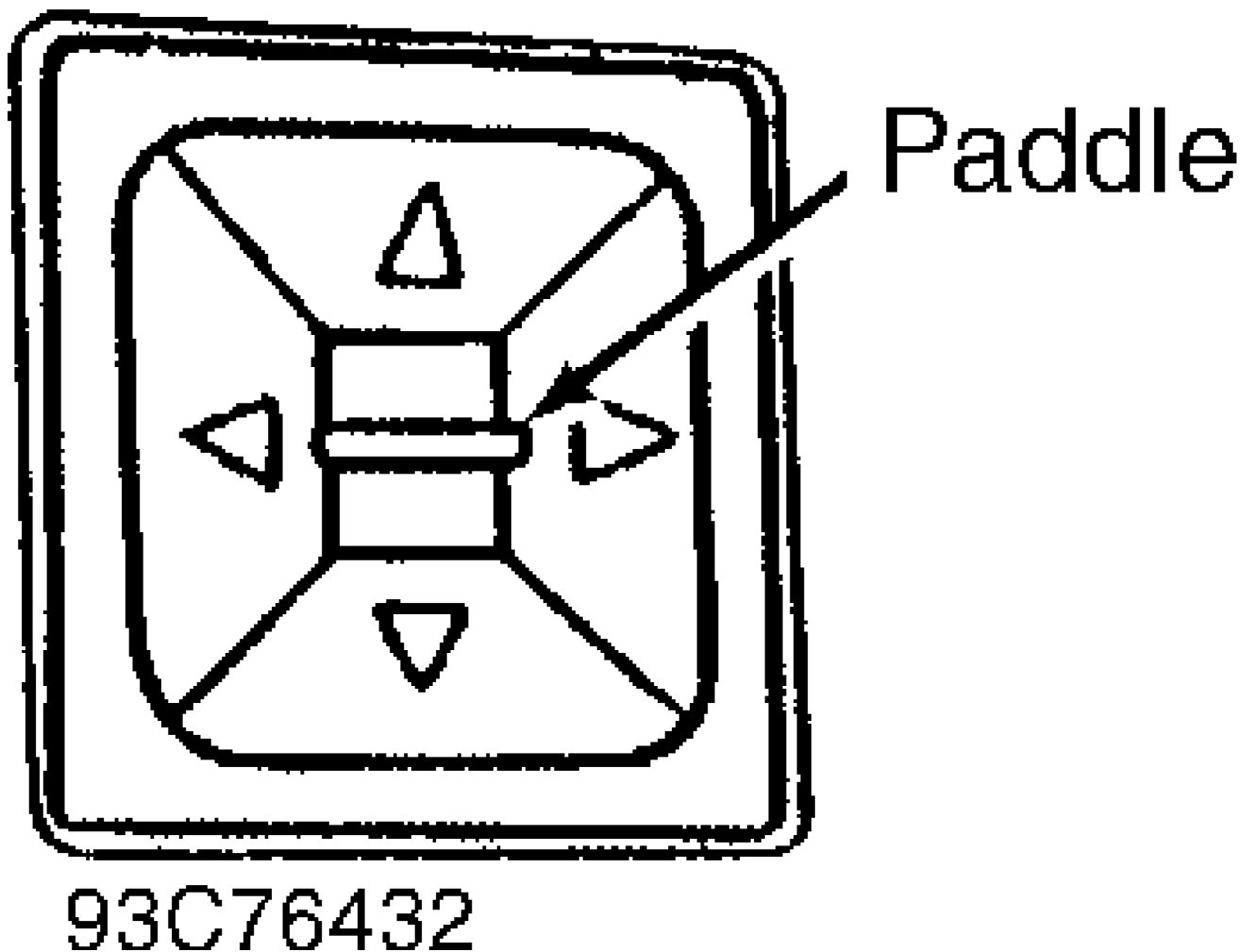


Fig. 3: Identifying Power Mirror Switch (Except Cherokee)  
Courtesy of Chrysler Corp.

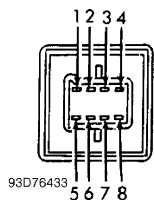


Fig. 4: Identifying Power Mirror Switch Terminals (Except Cherokee)  
Courtesy of Chrysler Corp.

## POWER MIRROR MOTOR

Remove door trim panel. Unplug harness connector. Connect a jumper wire to 12-volt power source. Connect another jumper wire to good body ground. Connect jumper wires to appropriate pin numbers. See POWER MIRROR MOTOR TEST table. See Fig. 5. If mirror reaction is not as specified, replace mirror assembly.

POWER MIRROR MOTOR TEST TABLE

12 Volts		Ground		Mirror Reaction
Pin No. 3	.....	Pin No. 1	.....	Up
Pin No. 1	.....	Pin No. 3	.....	Down
Pin No. 3	.....	Pin No. 2	.....	Right
Pin No. 2	.....	Pin No. 3	.....	Left
Pin No. 6	.....	Pin No. 5	.....	Heater

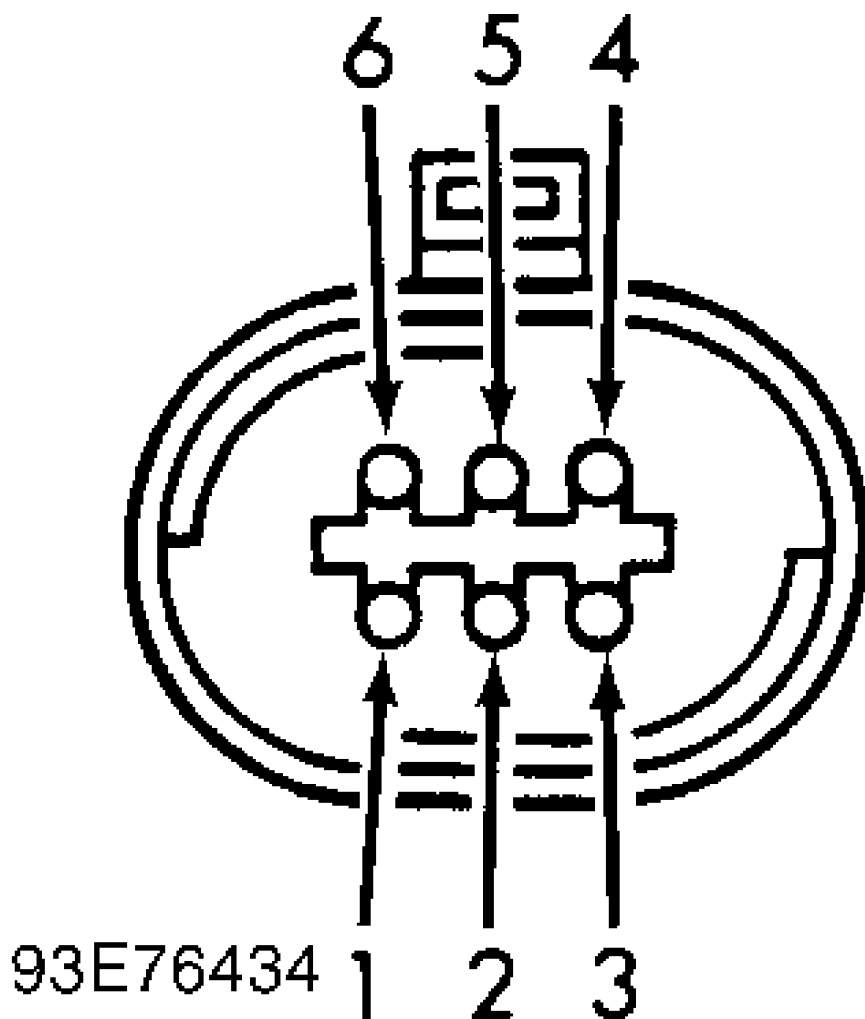


Fig. 5: Identifying Power Mirror Connector Terminals  
Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

## POWER MIRROR ASSEMBLY

NOTE: When removing door trim panel, start at bottom of panel.  
Pry panel free with wide, flat prying instrument.

### Removal & Installation (Cherokee)

1) Remove interior door latch release assembly and control panel retaining screws. Disconnect control linkage and wire harness connector. Remove latch release and control panel assembly. Remove armrest lower retaining screws.

2) Swing armrest downward to a vertical position. Disconnect armrest from upper retainer clip. Pull armrest straight out from trim panel. Remove trim panel.

3) Remove screw holding mirror trim cover. Disconnect power mirror wire harness at connector in door. Pull harness up through door. Remove 3 screws holding mirror to door. To install, reverse removal procedure.

### Removal & Installation (Except Cherokee)

Remove screws from demister opening armrest. Remove door handle cover screws. Remove door trim panel. Unplug mirror harness at connector. Remove 3 mounting nuts. Remove mirror. To install, reverse removal procedure

## POWER MIRROR SWITCH

### Removal & Installation (Cherokee)

Using a wide, thin flat blade tool, such as a putty knife, pry one side of switch housing away from center console. Remove switch from console. Carefully disconnect harness connector. To install, reverse removal procedure.

### Removal & Installation (Except Cherokee)

1) Disconnect negative battery cable. Remove ash tray. Remove center cluster bezel screws. Remove bezel. Remove screws holding dash pad behind top of center bezel. Pry defroster grille out of dash pad. Unplug sensors (if equipped) and set grille aside.

2) Remove screws holding dash pad to defroster duct and instrument panel cluster. Open glove box and remove screws holding dash pad. Remove dash pad by pulling up to unsnap clips.

3) Open driver's door. Remove screw from side of lower trim panel. Remove screw from bottom of lower trim panel. Unsnap and remove trim panel. Remove mirror switch bezel screws.

4) Pry switch bezel up sufficiently to unplug connector. Depress locking tabs and remove switch from bezel. To install, reverse removal procedure.

## WIRING DIAGRAMS

See appropriate chassis wiring diagram in WIRING DIAGRAMS.

# N - REMOVE/INSTALL/OVERHAUL

## 1993 Jeep Cherokee

1993 ENGINE PERFORMANCE

Chrysler Corp. Removal, Overhaul & Installation

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### INTRODUCTION

Removal, overhaul and installation procedures are covered in this article. If component removal and installation is primarily an unbolt and bolt-on procedure, only a torque specification may be furnished.

### IGNITION SYSTEM

#### DISTRIBUTOR

**CAUTION:** Base ignition timing is not adjustable on any 2.5L, 4.0L or 5.2L engine. Base ignition timing and timing advance are controlled by the PCM. Since a conventional timing light can not be used to adjust distributor after installation, ensure distributor is returned to its original position.

Removal (2.5L & 4.0L)

1) Disconnect negative battery cable. Remove distributor cap. Rotate engine crankshaft until distributor rotor is pointing toward cylinder No. 1 of distributor cap and engine is at TDC.

2) Scribe mark on distributor and adjacent component as reference to indicate rotor and distributor housing position when reinstalling distributor. Disconnect camshaft position sensor harness connector. Remove distributor hold-down nut. Lift distributor from engine.

Installation (2.5L & 4.0L)

1) Position distributor in engine. Ensure "O" ring is properly seated on distributor. Replace "O" ring if cracked or nicked. Carefully engage distributor driven gear with camshaft drive gear so when distributor is installed properly, rotor aligns with reference mark.

2) Install distributor cap. Check all high tension wires for good connections. Install hold-down nut. Connect camshaft position sensor wiring harness connector.

Removal (5.2L)

1) Disconnect negative battery cable. Remove distributor cap. Rotate engine crankshaft until distributor rotor is pointing toward cylinder No. 1 of distributor cap and engine is at TDC.

2) Scribe mark on distributor and adjacent component as reference to indicate rotor and distributor housing position when reinstalling distributor. Disconnect camshaft position sensor harness connector. Remove distributor hold-down nut. Lift distributor from engine.

Installation (5.2L)

**NOTE:** If engine has been rotated since distributor removal, return engine to TDC.

1) Clean mounting surface. Oil "O" ring on distributor housing. Position distributor in engine. Ensure "O" ring is properly

seated on distributor. Replace "O" ring if cracked or nicked. Carefully engage distributor driven gear with camshaft drive gear so when distributor is installed properly, rotor aligns with reference mark.

2) Install hold-down clamp and bolt but do not tighten. Rotate distributor housing until rotor is aligned with CYL. NO. 1 mark on camshaft position sensor. Tighten hold-down bolt to 200 INCH Lbs. (22.5 N.m).

3) Install distributor cap. Check all high tension wires for good connections. Connect camshaft position sensor wiring harness connector.

## **CAMSHAFT POSITION SENSOR**

Removal & Installation (2.5L & 4.0L)

Remove distributor. See DISTRIBUTOR. Remove rotor. Scribe mark on distributor driven gear and distributor shaft for reassembly reference. Using pin punch, drive out distributor roll pin. Lightly tap on end of distributor shaft until gear and thrust washer are removed. Remove distributor shaft from housing. Unbolt and remove camshaft position sensor. To install, reverse removal procedure.

Removal & Installation (5.2L)

Disconnect negative battery cable. Remove distributor cap. Disconnect camshaft position sensor connector from harness connector. Remove distributor rotor. Lift and remove sensor from distributor. To install, reverse removal procedure.

## **CRANKSHAFT POSITION SENSOR**

Removal (2.5 & 4.0L)

Disconnect sensor connector from main harness connector. Connector is located near rear of intake manifold. Raise and support vehicle. Remove sensor mounting bolts. Remove sensor. Sensor is mounted on transmission bellhousing.

Installation (2.5 & 4.0L)

To install, reverse removal procedure. Use only proper mounting bolt. Any other replacement bolt will cause improper sensor alignment. On Wrangler with 4.0L engine and automatic transmission, ensure paper self-adhesive spacer on end of sensor is replaced if old sensor is being reused. Paper spacer is used to set proper depth. Once engine is started, paper spacer wears away.

Removal (5.2L)

1) Remove spark plug cable loom and spark plug wires from mounting stud on rear of right valve cover. Remove right exhaust manifold heat shield. Disconnect hoses from EGR valve. Disconnect connector and hoses at EGR transducer.

2) Remove EGR valve. Disconnect connector at Oil Pressure Sending (OPS) unit. Using appropriate socket, remove OPS unit. Remove EGR tube. Disconnect crankshaft connector from harness connector. Remove crankshaft position sensor.

Installation (5.2L)

To install, reverse removal procedure. Replace all EGR valve and tube gaskets. Coat OPS unit threads with sealant before installing.

## **FUEL SYSTEM**

### **FUEL SYSTEM PRESSURE RELEASE**

**WARNING:** ALWAYS relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components.

1) Disconnect negative battery cable. Loosen fuel filler cap to release tank pressure. Remove protective cap from pressure test port on fuel rail. Using appropriate fuel pressure gauge/hose with gauge removed, place gauge end of hose into approved gasoline container.

2) To release pressure, screw other end of hose onto pressure test port. After pressure is released, remove hose from test port and install protective cap.

## FUEL RAILS & INJECTORS

Removal & Installation (2.5L & 4.0L)

1) Relieve fuel system pressure. See

FUEL SYSTEM PRESSURE RELEASE. Remove and tag injector wiring harness connectors from each injector. Disconnect vacuum hose from fuel pressure regulator.

2) Disconnect fuel supply and fuel return lines. Remove fuel rail mounting bolts. On automatic transmission vehicles, it may be necessary to remove throttle line pressure cable and bracket.

3) Gently rock fuel rail until all injectors clear intake manifold. Remove injector retaining clips and remove injectors. To install, reverse removal procedure. Ensure fuel injectors are properly seated in intake manifold.

**CAUTION:** The left and right fuel rails are replaced as an assembly. DO NOT attempt to separate rail halves at connecting hoses. DO NOT attempt to install a clamping device of any kind to hose(s). When removing fuel rail assembly, be careful not to bend or kink connecting hoses.

Removal (5.2L)

1) Release fuel system pressure. See

FUEL SYSTEM PRESSURE RELEASE. Disconnect negative battery cable. Remove air duct at throttle body. Remove throttle body from intake manifold. See THROTTLE BODY. Remove air conditioning compressor-to-intake manifold support bracket (if equipped).

2) Disconnect fuel injector wiring connectors (injector connectors are numerically tagged for installation reference). Remove vacuum line from fuel pressure regulator. Remove EVAP canister purge solenoid/bracket assembly from intake manifold.

3) Disconnect 2 rear fuel rail fuel lines, and remove remaining fuel rail mounting bolts. Gently rock and pull on left fuel rail and then right fuel rail until injectors start to clear intake manifold. Repeat procedure until injectors clear intake manifold, and remove fuel rail with injectors attached. Remove injector-to-fuel rail clips.

Installation (5.2L)

1) Lubricate injector "O" rings with a drop of clean engine oil. Install injectors and clips into fuel rail receiver cups. Ensure injectors and clips are fully seated. Position fuel rail/injector assembly on intake manifold openings. Using care not to tear "O" rings, guide each injector into intake manifold. Push right and then left fuel rail down until injectors are bottomed on injector shoulder.

2) To complete installation, reverse removal procedure. Connect negative battery cable, and check for leaks.

## FUEL PUMP

NOTE: Fuel tank removal is not necessary when removing fuel pump module on Cherokee and Grand Cherokee.

#### Removal & Installation (Cherokee)

1) Relieve fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE. Remove fuel tank filler cap. Drain fuel tank until fuel level is below 1/4 full. Raise and support vehicle. Disconnect fuel gauge sending unit connector.

2) Disconnect fuel tank vent hose and return hoses from fuel pump/fuel gauge sending unit. Using drift punch and hammer, carefully remove fuel pump lock ring counterclockwise. Remove fuel pump/fuel gauge sending unit and "O" ring. To install, reverse removal procedure.

#### Removal & Installation (Grand Cherokee)

Drain and remove fuel tank. See FUEL TANK. Fuel pump module lock nut is threaded onto fuel tank. Remove fuel pump module lock nut. Remove pump. To install, reverse removal procedure. Ensure new gasket is installed.

#### Removal & Installation (Wrangler)

Disconnect negative battery cable. Remove fuel tank. See FUEL TANK. Remove mounting bolts and fuel pump module. To install, reverse removal procedure. Start engine and check for leaks.

## FUEL TANK

#### Removal (Cherokee)

1) Disconnect negative battery cable. Remove fuel tank filler cap. Using an approved fuel storage container, drain fuel tank. Raise and support vehicle. Disconnect fuel fill hose and fill vent hose from filler neck. Disconnect fuel pump module wire connector.

2) Disconnect fuel tank vent hose. Disconnect fuel supply and return hoses from tank. Remove skid plate (if equipped). Remove fuel tank shield. Support fuel tank with transmission jack. Remove support straps. Lower and remove fuel tank.

#### Installation (Cherokee)

To install, reverse removal procedure. Start engine and check for leaks.

#### Removal & Installation (Grand Cherokee)

1) Disconnect negative battery cable. Release fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE. Raise and support vehicle. Remove fuel tank filler and vent hose at filler tube. Remove rear tow hooks (if equipped). Remove skid plate.

2) Remove trailer hitch (if equipped). Remove exhaust tailpipe heat shield. Disconnect fuel supply line at filter. Disconnect fuel return and vent lines at tank. Disconnect fuel pump module harness connector. Support fuel tank with transmission jack.

3) Remove tank strap nuts and move straps away from tank. Lower right side of tank while feeding fuel hoses through access hole in body. Remove filler hoses from tank. Insert siphon hose and drain tank. Lower and remove tank. To install, reverse removal procedure.

#### Removal & Installation (Wrangler)

1) Disconnect negative battery cable. Relieve fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE. Remove fuel tank filler cap, and siphon fuel out of fuel tank. Raise and support vehicle. Remove filler neck shroud. Disconnect filler vent hose and fuel filler hose from tank.

2) Disconnect fuel gauge sending unit connector. Remove tie



straps securing connector harness to fuel supply and return tubes. Disconnect fuel tank vent hose from vent tube.

3) Remove fuel tank shield and skid plate as single assembly. Support fuel tank with floor jack, and remove support strap nuts. Lower fuel tank and remove. To install, reverse removal procedure.

## THROTTLE BODY

### Removal & Installation (2.5L & 4.0L)

- 1) Disconnect negative battery cable. Remove air cleaner snorkel from throttle body. Disconnect idle air control motor and throttle position sensor connectors.
- 2) Disconnect accelerator cable, throttle cable (A/T), and speed (cruise) control cable (if equipped). Remove mounting bolts, throttle body, and gasket. To install, reverse removal procedure.

### Removal (5.2L)

- 1) Remove air duct. Release fuel system pressure. See FUEL SYSTEM PRESSURE RELEASE. Disconnect negative battery cable. Disconnect vacuum hoses and electrical connectors from throttle body.
- 2) Remove throttle cable, speed control cable and transmission cable (A/T). Remove throttle return spring. Remove fuel intake and return hoses. Remove throttle body mounting screws, and lift throttle body from vehicle. Remove throttle body gasket from intake manifold.

### Installation (5.2L)

- 1) Using a new gasket, install throttle body and tighten mounting screws. Install fuel intake and return hoses using new original-equipment type clamps.
- 2) Install throttle return spring. Install throttle cable. Install speed control and transmission kickdown cables (if equipped). Install wiring connectors and vacuum hoses. Install air cleaner. Reconnect negative battery cable.

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Coolant Temperature Sensor (2.5L & 4.0L) .....	21 (28)
Crankshaft Position Sensor (2.5L & 4.0L) .....	15 (19)
Distributor Hold-Down Bolt .....	17 (23)
Fuel Rail Bolt .....	20 (27)
Manifold Air Temperature Sensor .....	20 (27)
Oxygen (O2) Sensor .....	23 (31)
	INCH Lbs. (N.m)
Coolant Temperature Sensor (5.2L) .....	60 (7)
Crankshaft Position Sensor (5.2L) .....	70 (8)
Fuel Filter Strap Bolt .....	108 (12)
Throttle Body Bolt .....	108 (12)
Throttle Position Sensor Bolt .....	60 (7)

# **P - EGR FUNCTION TESTING**

1993 Jeep Cherokee

1990-95 ENGINE PERFORMANCE  
Jeep EGR Function Testing

All Models

## **EGR VALVE**

### **PORTED EGR SYSTEM**

1) Check vacuum hoses for correct routing. Warm engine to normal operating temperature. Set engine speed to fast idle (or high enough to obtain 5 in Hg at EGR valve). Protect finger from heat and place finger beneath EGR valve so diaphragm movement can be felt.

2) Disconnect vacuum hose from EGR valve. Diaphragm should move downward (valve closed) and increase in engine RPM should be noticed. Reconnect vacuum hose to EGR valve. Diaphragm should move upward (valve open) and engine speed should decrease by at least 150 RPM.

3) If EGR diaphragm does not move during the test, check for vacuum at hose. If vacuum is present, replace EGR valve. If vacuum is not present, check for leaking vacuum hose or plugged carburetor port. If EGR diaphragm moves during the test, but RPM does not change, check for plugged EGR port or passages.

# PARASITIC LOAD EXPLANATION & TEST PROCEDURES

1993 Jeep Cherokee

## GENERAL INFORMATION

Parasitic Load Explanation & Test Procedures

### \* PLEASE READ THIS FIRST \*

This article is provided for general information only. Not all procedures apply to all makes and models.

## GENERAL INFORMATION

The term Parasitic Load refers to electrical devices that continue to use or draw current after the ignition switch is turned to OFF position. This small amount of continuous battery draw is expressed in milliamps (mA). On Ford Motor Co. and General Motors vehicles produced after 1980, a typical Parasitic Load should be no more than 50 milliamps (0.050 amps).

Vehicles produced since 1980 have memory devices that draw current with ignition off for as long as 20 minutes before shutting down the Parasitic Drain. When Parasitic Load exceeds normal specifications, the vehicle may exhibit dead battery and no-start condition.

Follow test procedure for checking Parasitic Loads to completion. A brief overview of a suggested test procedure is included along with some typical Parasitic Load specifications. Refer to the GENERAL MOTORS PARASITIC LOAD TABLE chart.

## TESTING FOR PARASITIC LOAD

### INTRODUCTION

**CAUTION:** Always turn ignition off when connecting or disconnecting battery cables, battery chargers or jumper cables. DO NOT turn test switch to OFF position (which causes current to run through ammeter or vehicle electrical system).

**NOTE:** Memory functions of various accessories must be reset after the battery is reconnected.

The battery circuit must be opened to connect test switch (shunt) and ammeter into the circuit. When a battery cable is removed, timer circuits within the vehicle computer are interrupted and immediately begin to discharge. If in doubt about the condition of the ammeter fuse, test it with an ohmmeter prior to beginning test. An open fuse will show the same reading (00.00) as no parasitic drain. Begin test sequence with the meter installed and on the 10-amp scale. Select lower scale to read parasitic draw.

### TEST PROCEDURE USING TEST SWITCH

1) Turn ignition off. Remove negative battery terminal cable. Install Disconnect Tool (J-38758) test switch male end to negative battery cable. Turn test switch knob to OFF position (current through meter). Install negative battery cable to the female end of test switch.

2) Turn test switch knob to ON position (current through switch). Road test vehicle with vehicle accessories on (radio, air conditioner, etc.). After road test, turn ignition switch to LOCKED position and remove key. Connect ammeter terminals to test switch

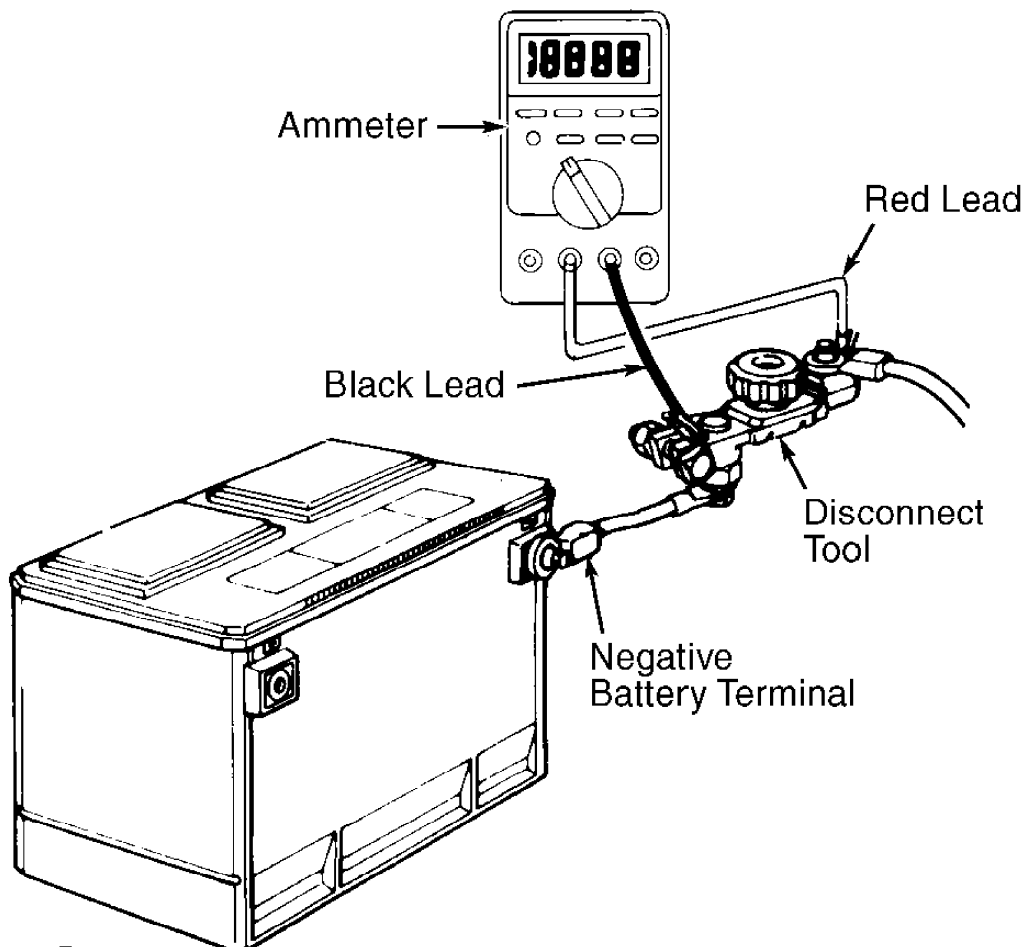
terminals. See Fig. 1. Select 10-amp scale.

3) Turn off all electrical accessories. Turn off interior lights, underhood lamp, trunk light, illuminated entry, etc. To avoid damaging ammeter or obtaining a false meter reading, all accessories must be off before turning test switch knob to OFF position.

4) Turn test switch knob to OFF position to allow current to flow through ammeter. If meter reads wrong polarity, turn test switch to ON position and reverse leads. Turn test switch to OFF position. Observe current reading. If reading is less than 2 amps, turn test switch to ON position to keep electrical circuits powered-up.

5) Select low amp scale. Switch lead to the correct meter position. Turn test switch to OFF position and compare results to normal current draw. See the GENERAL MOTORS PARASITIC LOAD TABLE. If current draw is unusually high for the vehicle's overall electrical system, remove system fuses one at a time until current draw returns to normal.

6) Turn test switch to ON position each time door is opened or fuse is removed. Turn switch to OFF position to read current draw value through meter. When the cause of excessive current drain has been located and repaired, remove test switch and reconnect negative battery cable to the negative battery terminal.



92F03911

Fig. 1: Connecting Kent-Moore Disconnect Tool (J-38758)  
Courtesy of General Motors Corp.

GENERAL MOTORS PARASITIC LOAD TABLE (MILLIAMPS)

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Component	Normal Draw		Maximum Draw	Time-Out (Minutes)
Anti-Theft System .....	0.4	.....	1.0	.....
Auto Door Lock .....	1.0	.....	1.0	.....
Body Control Module .....	3.6	...	12.4	..... 20
Central Processing System .....	1.6	.....	2.7	..... 20
Electronic Control Module .....	5.6	...	10.0	.....
Electronic Level Control .....	2.0	.....	3.3	..... 20
Heated Windshield Module .....	0.3	.....	0.4	.....
HVAC Power Module .....	1.0	.....	1.0	.....
Illuminated Entry .....	1.0	.....	1.0	..... 1
Light Control Module .....	0.5	.....	1.0	.....
Oil Level Module .....	0.1	.....	0.1	.....
Multi-Function Chime .....	1.0	.....	1.0	.....
Pass Key Decoder Module .....	0.75	.....	1.0	.....
Power Control Module .....	5.0	.....	7.0	.....
Retained Accessory Power .....	3.8	.....	3.8	.....
Radio .....	7.0	.....	8.0	..... 15
Twilight Sentinel Module .....	1.0	.....	1.0	.....
Voltage Regulator .....	1.4	.....	2.0	.....

## INTERMITTENT PARASITIC LOAD PROBLEMS

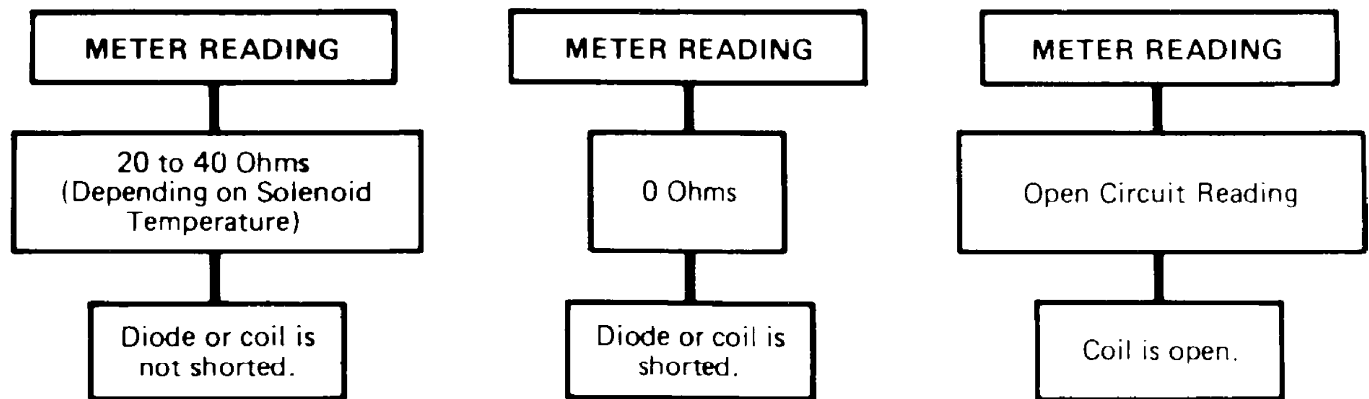
Intermittent parasitic load can occur because of a memory device that does not power down with ignition off. With an intermittent parasitic load, battery draw can be greater than 1.0 amp. To find and intermittent problem requires that an ammeter and Disconnect Tool (J-38758) test switch be connected and left in the circuit. See Fig. 1. Road test vehicle. After road test, turn ignition off and remove key.

Monitor the milliamps scale for 15-20 minutes after ignition is turned off. This allows monitoring memory devices to determine if they time out and stop drawing memory current. The test switch is needed to protect ammeter when the vehicles is started.

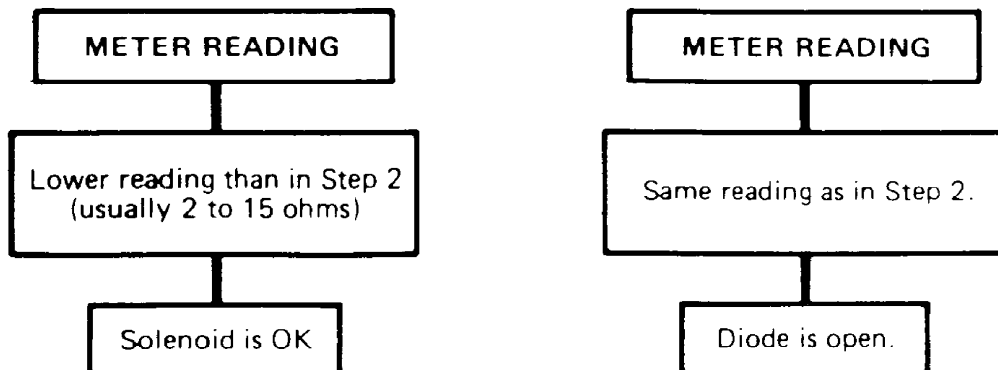
## DIODE CHECK & SOLENOID TEST (GENERAL MOTORS)

**Step 1)** Select the X1 SCALE and zero the needle.

**Step 2)** Attach the POSITIVE SOLENOID LEAD (Red lead) to the POSITIVE METER LEAD and the NEGATIVE SOLENOID LEAD (Black lead) to the NEGATIVE METER LEAD.

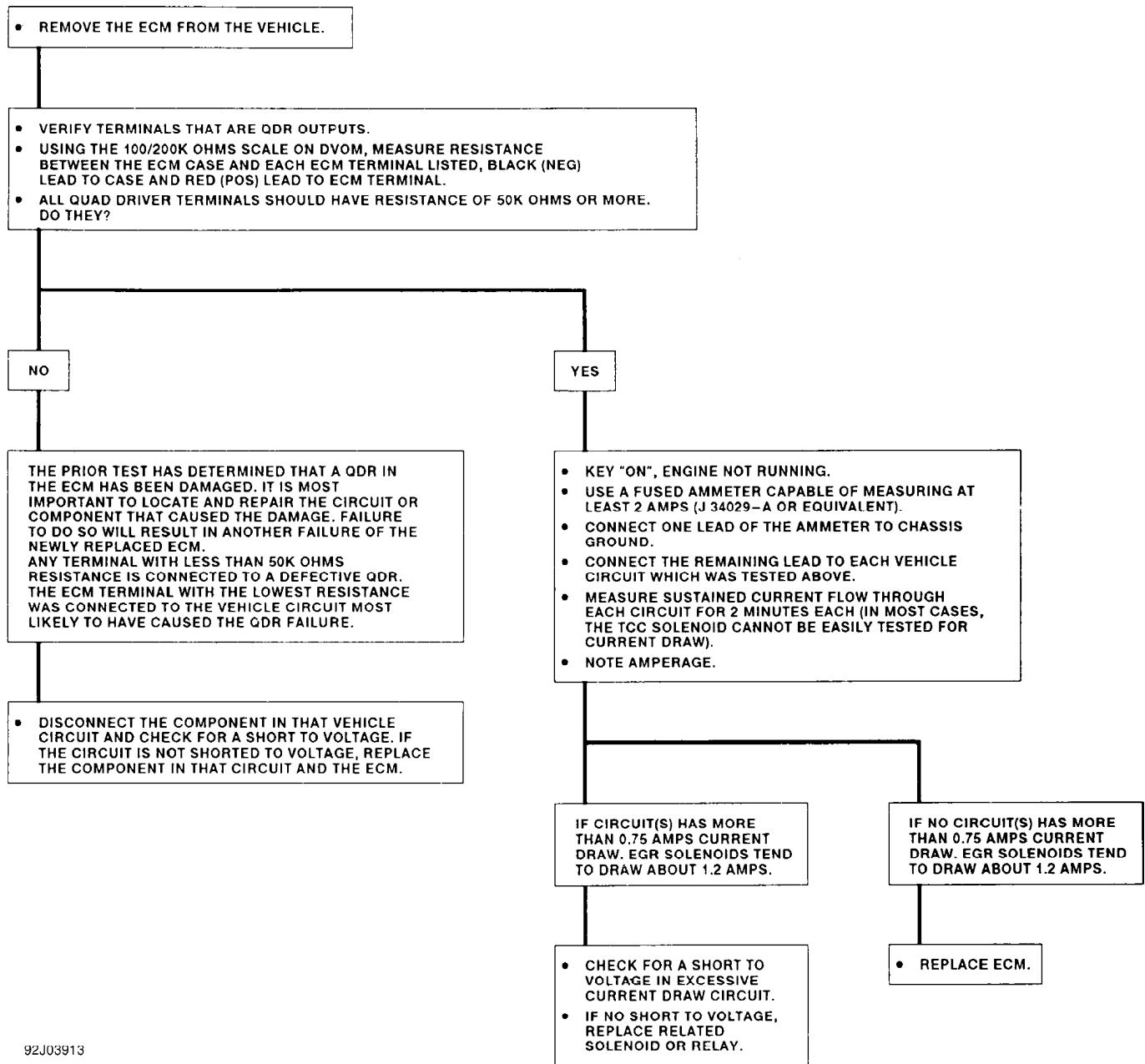


**Step 3)** Reverse the solenoid lead attachments.



92H03912  
Fig. 2: Diode Check & Solenoid Test (General Motors)  
Courtesy of General Motors Corp.

#### QUAD DRIVER TEST (GENERAL MOTORS)



92J03913

Fig. 3: Quad Driver Test (General Motors)  
Courtesy of General Motors Corp.

# **PRE-ALIGNMENT CHECKS**

1993 Jeep Cherokee

Wheel Alignment  
PRE-ALIGNMENT INSPECTION PROCEDURES

## **PRE-ALIGNMENT CHECKS**

Before making wheel alignment adjustment, perform the following checks:

- 1) Tires should be equal in size and runout must not be excessive. Tires and wheels should be in balance, and inflated to manufacturer's specifications.
- 2) Wheel bearings must be properly adjusted. Steering linkage and suspension must not have excessive looseness. Check for wear in tie rod ends and ball joints.
- 3) Steering gear box must not have excessive play. Check and adjust to manufacturer's specifications.
- 4) Vehicle must be at curb height with full fuel load and spare tire in vehicle. No extra load should be on vehicle.
- 5) Vehicle must be level with floor and with suspension settled. Jounce front and rear of vehicle several times and allow it to settle to normal curb height.
- 6) If steering wheel is not centered with front wheels in straight-ahead position, correct by shortening one tie rod adjusting sleeve and lengthening opposite sleeve equal amounts.
- 7) Ensure wheel lug nuts are tightened to torque specifications.



# **RECALL 681 - 2.5L ENG OUTSIDE CALIF. CATALYTIC CONV.**

1993 Jeep Cherokee

## **EMISSION RECALL BULLETIN**

### **EMISSIONS RECALL #680 - CATALYTIC CONVERTER**

Model(s) : 1991-1995 Jeep Cherokee (XJ)  
1991-1995 Jeep Wrangler (YJ)  
1991-1992 Jeep Comanche (MJ) Vehicles  
Bulletin No.: 681  
Date: May, 1996

NOTE: This is an Emission Recall bulletin.

## **VEHICLES AFFECTED**

Vehicles Listed Below Which Are Equipped With a 2.5L Engine and Are Currently Located Outside of California:

- \* 1991 through 1995 Model Year Jeep Cherokee (XJ) Vehicles Built Through February 14, 1995 (MOH 021411)
- \* 1991 Through 1995 Model Year Jeep Wrangler (YJ) Vehicles Built Through February 7, 1995 (MDH 020712)
- \* 1991 and 1992 Model Year Jeep Comanche (MJ) Vehicles

## **SERVICE INFORMATION**

Failure of the catalytic converter on the above listed vehicles, may cause a vehicle to be in violation of U.S. Environmental Protection Agency (EPA) Emissions Standards. To correct this condition, the catalytic converter must be replaced. Vehicles which are located in California will be serviced under California Emissions Recall #680.

Details of this service action are explained in the following sections.

## **SERVICE PROCEDURE VIDEOTAPE**

No videotape of the service procedure for this recall will be provided.

## **DEALER NOTIFICATION & VEHICLE LIST**

### **INVOLVED DEALERS**

Each dealer to whom involved vehicles were invoiced (or the current dealer at the same street address) will receive a copy of this dealer recall notification letter and a list of the involved vehicles by first class mail.

The Vehicle List is arranged in Vehicle Identification Number (VIN) sequence. Owners known to Chrysler are also listed. The lists are for dealer reference in arranging for service of involved vehicles as necessary.

### **ALL CALIFORNIA DEALERS**

Each Jeep & Eagle dealer who does not receive a Vehicle List will receive a copy of this dealer recall notification letter by first class mail.

## DIAL SYSTEM FUNCTION 70 AND VIP

All involved vehicles will be entered to DIAL System Function 70 and VIP at the time of recall implementation for dealer inquiry by VIN as needed.

## PARTS INFORMATION

**IMPORTANT:** A quantity of parts will be distributed initially and billed to all involved dealers. This quantity will cover a portion of the total vehicles involved. Additional parts may be ordered as needed to support customer demand.

Each involved dealer, to whom vehicles in the recall were invoiced (or the current dealer at the same street address), will receive enough Catalytic Converter Packages, Recall PN CLER6811 (for 1991 and 1992 model year vehicles), and Recall PN CLKG6812 for (1993, 1994 and 1995 model year vehicles) to service 25% of those vehicles.

Each parts package contains the following components:

### CATALYTIC CONVERTER PACKAGES

91/92 MY Vehicles (CLER6811)		93/94/95 MY Vehicles (CKLG6812)	
Qty	Description	Qty	Description
1	Catalytic Converter	1	Catalytic Converter
1	Clamp	2	Clamp
4	Bolts	1	Recall Completion Label
4	Nuts	1	Instruction Sheet
1	Gasket		
1	Recall Completion Label		
1	Instruction Sheet		

## OWNER NOTIFICATION & SERVICE SCHEDULING

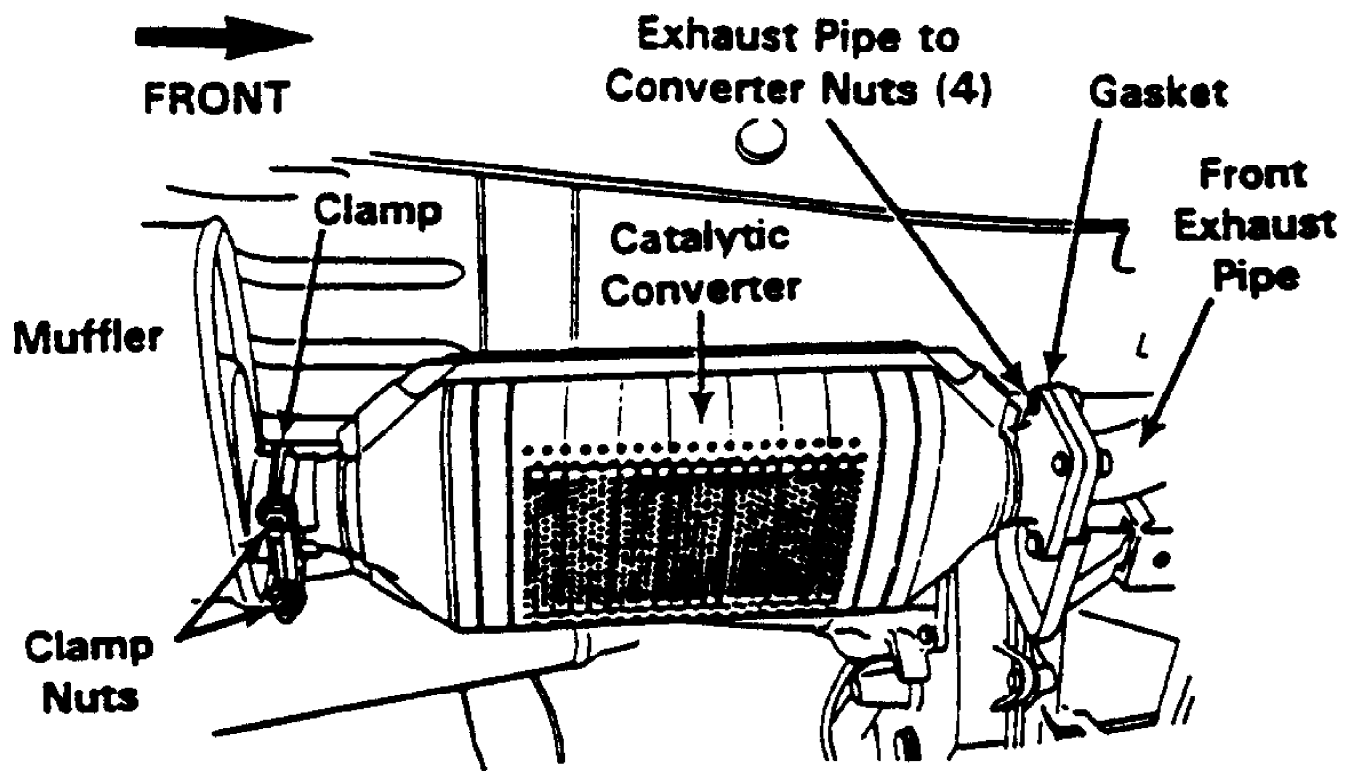
All involved vehicle owners known to Chrysler are being notified of the service requirement by first class mail. They are requested to schedule appointments for the service with their dealers at the earliest possible date. A copy of the CUSTOMER NOTIFICATION LETTER is in this bulletin.

Enclosed with each owner notification is an Owner Notification Form. The involved vehicle and recall are identified on the form for owner or dealer reference as needed.

3. Remove and discard the nuts, bolts and gasket at the front of the converter and the exhaust pipe clamp at the rear (see Fig. 1).

**NOTE:** Use penetrating oil if necessary.

4. Place a block of wood against the rear of the converter and drive the clamp converter forward to disengage the alignment tab on the converter pipe from the alignment slot on the muffler.



**97C55550**

Fig. 1: Removing Converter and Exhaust Pipe Clamp

NOTE: If the converter does not move forward, it may be necessary to heat the converter to muffler connection with an oxyacetylene torch until the metal becomes cherry red.

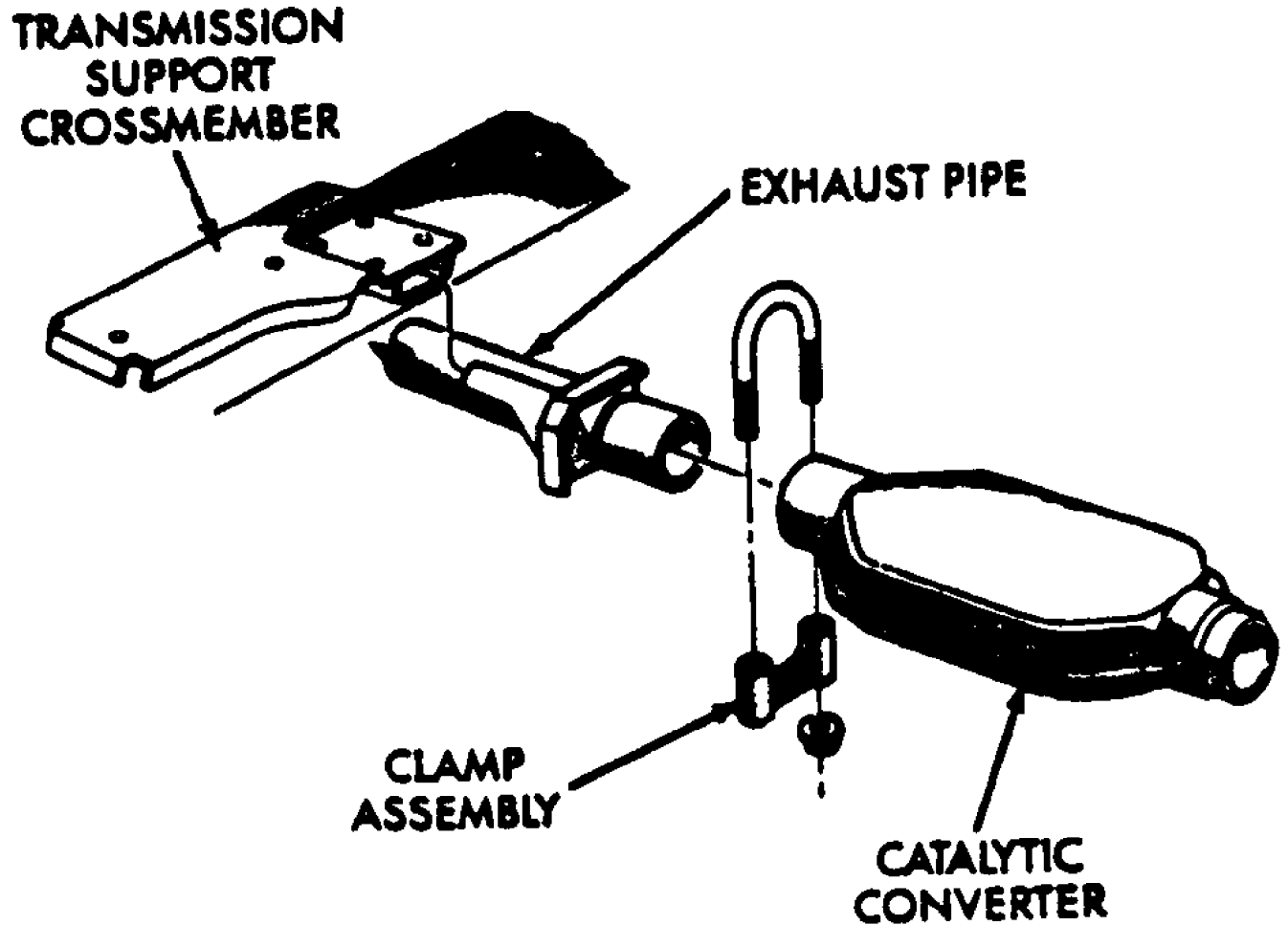
5. Twist the converter back and forth to separate it from the muffler.
6. Install the new converter into the muffler until the alignment tab is inserted into the alignment slot.
7. Using the provided gasket, nuts and bolts, attach the converter to the front exhaust pipe. Do not tighten the bolts.
8. Install and tighten the new exhaust pipe clamp, at the muffler to converter connection, to 40 ft-lbs (57 N-m).
9. Tighten the converter to front exhaust pipe bolts to 25 ft-lbs (34 N-m).
10. On Wrangler (YJ) vehicles:  
Install the skid plate.
11. Lower vehicle.

## **SERVICE PROCEDURE FOR 1993, 1994 AND 1995 MY VEHICLES**

### **A. REPLACE CATALYTIC CONVERTER**

WARNING: IF TORCHES ARE USED WHEN WORKING ON THE EXHAUST SYSTEM, DO NOT ALLOW THE FLAME NEAR THE FUEL LINES.

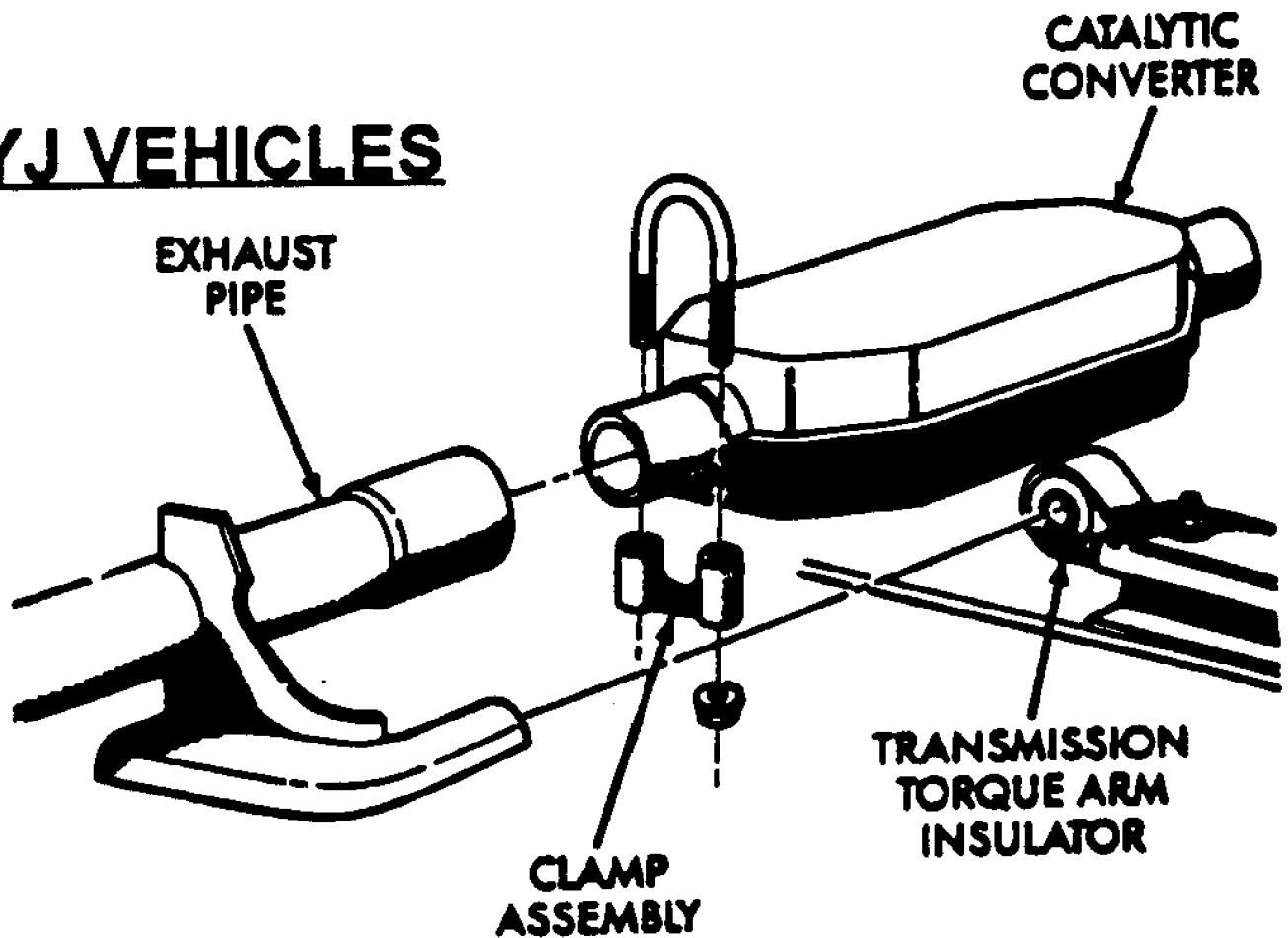
1. Raise vehicle on an appropriate hoist.
2. On Wrangler (YJ) vehicles: Support the transmission and remove the skid plate.
3. Remove the U-bolt clamps from the exhaust pipe and muffler connections at the front (see Fig. 2 and 3) and rear (see Fig. 4) of the catalytic converter.



97C56921

Fig. 2: U-Bolt Clamps and Muffler Connections (XJ Vehicles)

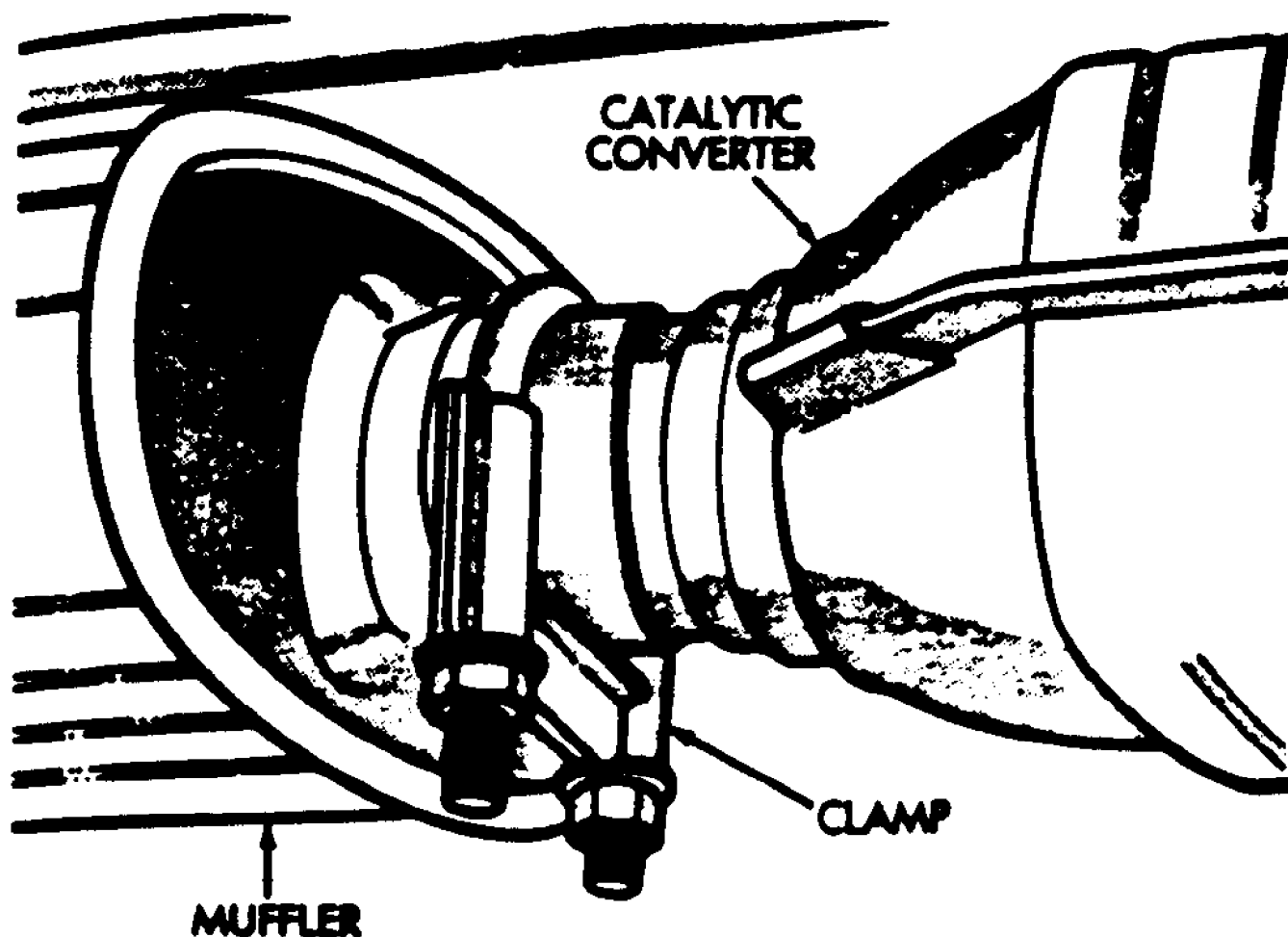
# YJ VEHICLES



**97H55548**

Fig. 3: U-Bolt Clamps and Muffler Connections (YJ Vehicles)

4. Heat the catalytic converter to muffler connection with an oxyacetylene torch until the metal becomes cherry red.
5. While the metal is still cherry red, twist the muffler assembly back and forth to separate it from the converter.
6. Disconnect the front exhaust pipe from the catalytic converter. If necessary, heat the pipe connection as described above.
7. Connect the supplied catalytic converter to the front exhaust pipe. Use one of the supplied clamps and tighten the nuts to 45 ft-lbs (61 N.m).
8. Install the muffler on to the catalytic converter until the alignment tab is inserted into the alignment slot.
9. Install and tighten the new exhaust pipe clamp, at the muffler to converter connection, to 45 ft-lbs (61 Nm). See Fig. 4.



97155549

Fig. 4: U-Bolt Clamps and Muffler Connections (Rear)

10. On Wrangler (YJ) vehicles:  
Install the skid plate.
11. Lower the vehicle.

#### COMPLETION REPORTING AND REIMBURSEMENT

Claims for vehicles which have been serviced must be submitted on the DIAL System Claims submitted will be used by Chrysler to record recall service completions and provide dealer payments.

Use the following labor operation number and time allowance:

	Labor Operation Number	Time Allowance
Replace Catalytic Converter .....	11681182	0.7 Hours

Add the cost of the recall parts package plus applicable dealer

allowance to your claim.

## PARTS RETURN

Removed catalytic converters must be returned to the Warranty Material Return Center.

NOTE: See Warranty Policy and Procedure Manual, Chapter 6, Subsection H for complete recall claim processing and material return instructions.

## VEHICLE NOT AVAILABLE

If a vehicle is not available for service for a known reason, let us know by filling out the pre-addressed Vehicle Disposition Form portion of the Owner Notification Form, or describe the reason on a postcard and mail to:

Chrysler Corporation  
CIMS 482-00-85  
800 Chrysler Drive East  
Auburn Hills, Michigan 48326-2757

Following the above procedures will expedite the processing of your claim.

If you have any questions or need assistance in completing this action, please contact your Zone Service Office.

Customer Services Field Operations  
Chrysler Corporation

## CUSTOMER NOTIFICATION LETTER

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### EMISSIONS RECALL TO REPLACE YOUR VEHICLE'S CATALYTIC CONVERTER

Dear Jeep Vehicle Owner:

Chrysler has determined that some 1991 through 1995 Jeep Cherokee, Comanche and Wrangler vehicles equipped with a 2.5L engine, may be in violation of Federal Emissions Standards.

The Problem is... The catalytic converter on your vehicle (identified on the enclosed form), may be susceptible to failure. Failure of the catalytic converter could result in hydrocarbon (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) levels above the allowable limits which were established to protect the public health from the dangers of air pollution.

What Chrysler and your dealer will do... Chrysler will repair your vehicle free of charge (parts and labor). To do this, your dealer will replace the catalytic converter. The work will take about one hour to complete. However, additional time may be necessary depending on how dealer appointments are scheduled and processed.

What you must do... \* Simply contact your Jeep & Eagle dealer to schedule a service appointment. Ask the dealer to

hold the parts for your vehicle or to order them before your appointment.

- \* Bring the enclosed Owner Notification Form with you to your dealer, It explains the required service to your dealer.

If you need help...

If you have trouble getting your vehicle repaired, please call the Chrysler Customer Center, toll free, at 1-800-853-i403. A representative will assist you in getting your vehicle repaired. If you are still unable to obtain the repair as described in this letter within a reasonable time, you may also contact the Vehicle Programs and Compliance Division of the Environmental Protection Agency (6405J), 401 M Street, S.W. Washington, D.C. 20460.

In order to ensure your full protection under the emission warranty made applicable to your vehicle under Federal law, and your right to participate in future recalls, it is recommended that you have your vehicle serviced as soon as possible. Failure to do so could legally be determined to be a lack of proper maintenance of your vehicle. Further, without this repair your vehicle may fail a state or local emission inspection test.

We're sorry for any inconvenience, but trust that you understand our interest in clean air and your continuing satisfaction with our product. Thanks for your attention to this important matter.

Customer Services Field Operations  
Chrysler Corporation



# RECALL 680 - 2.5L ENG - CATALYTIC CONVERTER PACKAGE

1993 Jeep Cherokee

## EMISSION RECALL BULLETIN

### CALIFORNIA EMISSIONS RECALL #680 - CATALYTIC CONVERTER

Model(s): 1991-95 Jeep Cherokee (XJ)  
1991-95 Jeep Wrangler (YJ)  
1991-92 Jeep Comanche (MJ) Vehicles  
Bulletin No.: 680  
Date: March, 1996

NOTE: This is an Emission Recall bulletin.

## VEHICLES AFFECTED

Vehicles Listed Below Which Are Equipped With a 2.5L Engine and Are Currently Located in California:

- \* 1991 Through 1995 Model Year Jeep Cherokee (XJ) Vehicles Built Through February 14, 1995 (MOM 021411)
- \* 1991 Through 1995 Model Year Jeep Wrangler (YJ) Vehicles Built Through February 7, 1995 (MDH 020712)
- \* 1991 and 1992 Model Year Jeep Comanche (MJ) Vehicles

## SERVICE INFORMATION

Failure of the catalytic converter on the above listed vehicles, may cause a vehicle to be in violation of California Air Resources Board (CARB) and/or U.S. Environmental Protection Agency (EPA) Emissions Standards. To correct this condition the catalytic converter must be replaced. Vehicles which are located outside of California will be serviced under Emissions Recall #681.

IMPORTANT: This recall is subject to the State of California Registration Renewal/Emissions Recall Enforcement Program. Involved vehicles must have the recall service completed before registration renewal.

The servicing dealer must provide a Vehicle Emission Recall Proof of Correction Form (Form No. 81-016-1053) to each owner upon completion of the recall service, for use as proof in renewal of the vehicle registration.

Details of this service action are explained in the following sections.

## SERVICE PROCEDURE VIDEOTAPE

No videotape of the service procedure for this recall will be provided.

## DEALER NOTIFICATION & VEHICLE LIST

### INVOLVED DEALERS

Each dealer to whom involved vehicles were invoiced (or the current

dealer at the same street address) will receive a copy of this dealer recall notification letter and a list of the involved vehicles by first class mail.

The Vehicle List is arranged in Vehicle Identification Number (VIN) sequence. Owners known to Chrysler are also listed. The lists are for dealer reference in arranging for service of involved vehicles as necessary.

## ALL OTHER CALIFORNIA DEALERS

Each California Jeep & Eagle dealer who does not receive a Vehicle List will receive a copy of this dealer recall notification letter by first class mail.

## DIAL SYSTEM FUNCTION 70

All involved vehicles will be entered to DIAL System Function 70 at the time of recall implementation for dealer inquiry by VIN as needed.

## RECALL COMPLETION LABEL REQUIREMENT

There is a California Air Resources Board requirement to affix a label to the vehicle to certify that the emissions recall was completed. A label is included in each emissions service parts package. Refer to the Service Procedure of this letter for application instructions.

## PARTS INFORMATION

**IMPORTANT:** A quantity of parts will be distributed initially and billed to all involved dealers. This quantity will cover a portion of the total vehicles involved. Additional parts may be ordered as needed to support customer demand.

Each involved dealer, to whom vehicles in the recall were invoiced (or the current dealer at the same street address), will receive enough Catalytic Converter Packages, Recall PN CHAR6801 (for 1991 and 1992 model year vehicles), and Recall PN CHBG6802 for (1993, 1994 and 1995 model year vehicles) to service 25% of those vehicles.

Each parts package contains the following components:

### CATALYTIC CONVERTER PACKAGES

91/92 MY Vehicles (CHARS801)		93/94/95 MY Vehicles (CHBG6802)	
Qty	Description	Qty	Description
1	Catalytic Converter	1	Catalytic Converter
1	Clamp	2	Clamp
4	Bolts	1	Recall Completion Label
4	Nuts	1	Instruction Sheet
1	Gasket		
1	Recall Completion Label		
1	Instruction Sheet		

## OWNER NOTIFICATION & SERVICE SCHEDULING

All involved vehicle owners known to Chrysler are being notified of

the service requirement by first class mail. They are requested to schedule appointments for the service with their dealers at the earliest possible date. A copy of the CUSTOMER NOTIFICATION LETTER is in this bulletin.

Enclosed with each owner notification is an Owner Notification Form. The involved vehicle and recall are identified on the form for owner or dealer reference as needed.

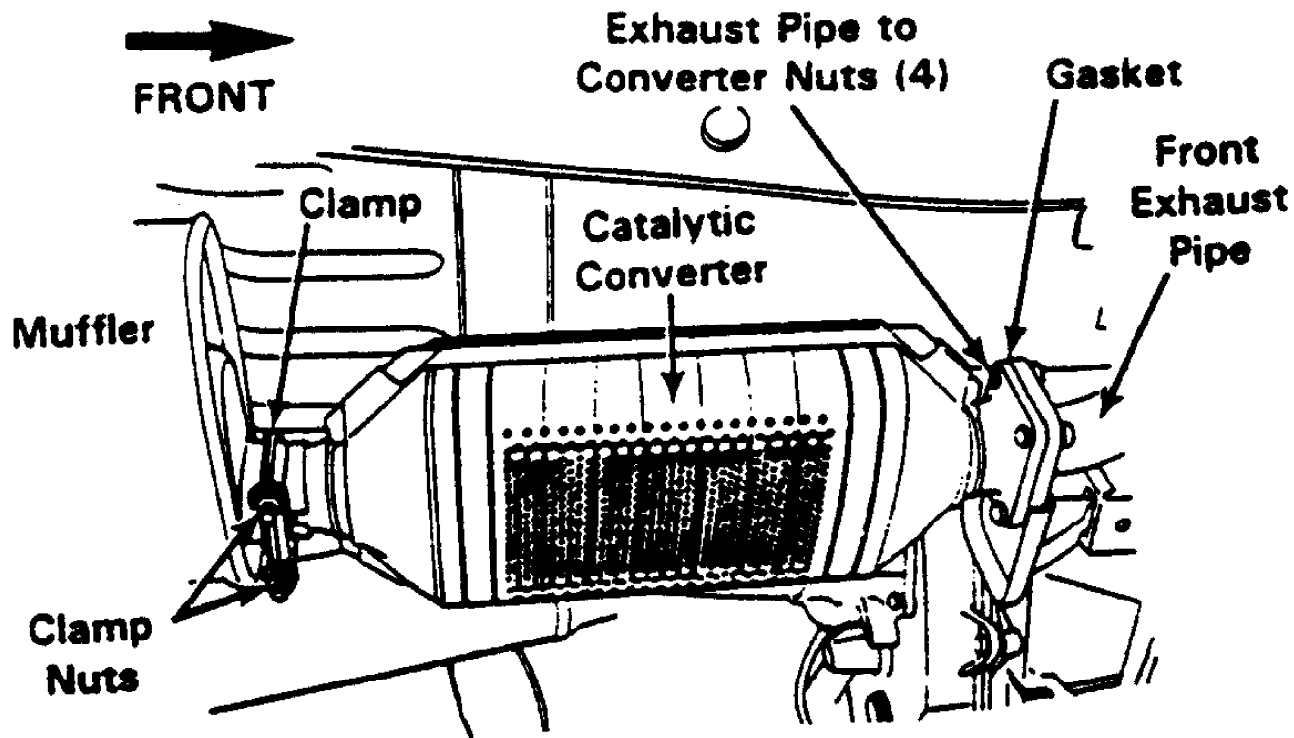
## A. REPLACE CATALYTIC CONVERTER

**WARNING:** IF TORCHES ARE USED WHEN WORKING ON THE EXHAUST SYSTEM, DO NOT ALLOW THE FLAME NEAR THE FUEL LINES.

1. Raise vehicle on an appropriate hoist.
2. On Wrangler (YJ) vehicles:  
Support the transmission and remove the skid plate.
3. Remove and discard the nuts, bolts and gasket at the front of the converter and the exhaust pipe clamp at the rear (see Fig. 1).

**NOTE:** Use penetrating oil if necessary.

4. Place a block of wood against the rear of the converter and drive the clamp converter forward to disengage the alignment tab on the converter pipe from the alignment slot on the muffler.



97F55546

Fig. 1: Removing Converter and Exhaust Pipe Clamp

**NOTE:** If the converter does not move forward, it may be necessary to heat the converter to muffler connection with an oxyacetylene torch until the metal becomes cherry red.

5. Twist the converter back and forth to separate it from the muffler.
6. Install the new converter into the muffler until the alignment tab is inserted into the alignment slot.
7. Using the provided gasket, nuts and bolts, attach the converter to the front exhaust pipe. Do not tighten the bolts.
8. Install and tighten the new exhaust pipe clamp, at the muffler to converter connection, to 40 ft-lbs (57 N-m).
9. Tighten the converter to front exhaust pipe bolts to 25 ft-lbs (34 N-m).
10. On Wrangler (YJ) vehicles:  
Install the skid plate.
11. Lower vehicle.

## **B. INSTALL RECALL COMPLETION LABEL**

1. With a ball point pen, print your dealer code (5 digits) on the supplied Recall Completion Label.
2. Peel the label from its backing and apply it near the Vehicle Emissions Control Information Label on the underside of the hood.

## **C. COMPLETE PROOF OF CORRECTION FORM**

1. Complete a Vehicle Emission Recall Proof of Correction Form and supply it to the vehicle owner.

## **SERVICE PROCEDURE FOR 1993, 1994 AND 1995 MY VEHICLES**

### **A. REPLACE CATALYTIC CONVERTER**

**WARNING:** IF TORCHES ARE USED WHEN WORKING ON THE EXHAUST SYSTEM, DO NOT ALLOW THE FLAME NEAR THE FUEL LINES.

1. Raise vehicle on an appropriate hoist.
2. On Wrangler (YJ) vehicles:  
Support the transmission and remove the skid plate.
3. Remove the U-bolt clamps from the exhaust pipe and muffler connections at the front (see Fig. 2 and 3) and rear (see Fig. 4) of the catalytic converter.
4. Heat the catalytic converter to muffler connection with an oxyacetylene torch until the metal becomes cherry red.

**TRANSMISSION  
SUPPORT  
CROSSMEMBER**

**EXHAUST PIPE**

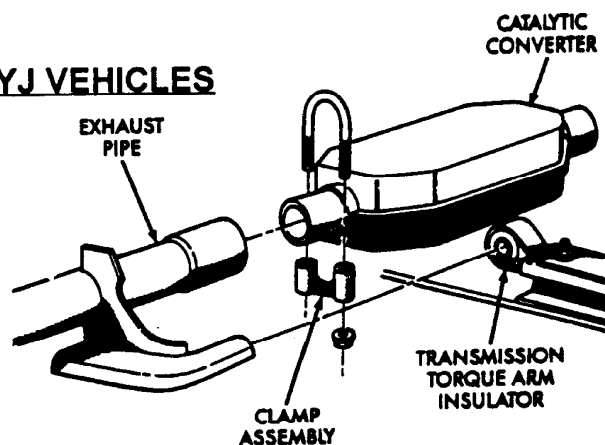
**CLAMP  
ASSEMBLY**

**CATALYTIC  
CONVERTER**

**97C56921**

Fig. 2: Front U-Bolt Clamps and Muffler Connections (XJ Vehicles)

**YJ VEHICLES**

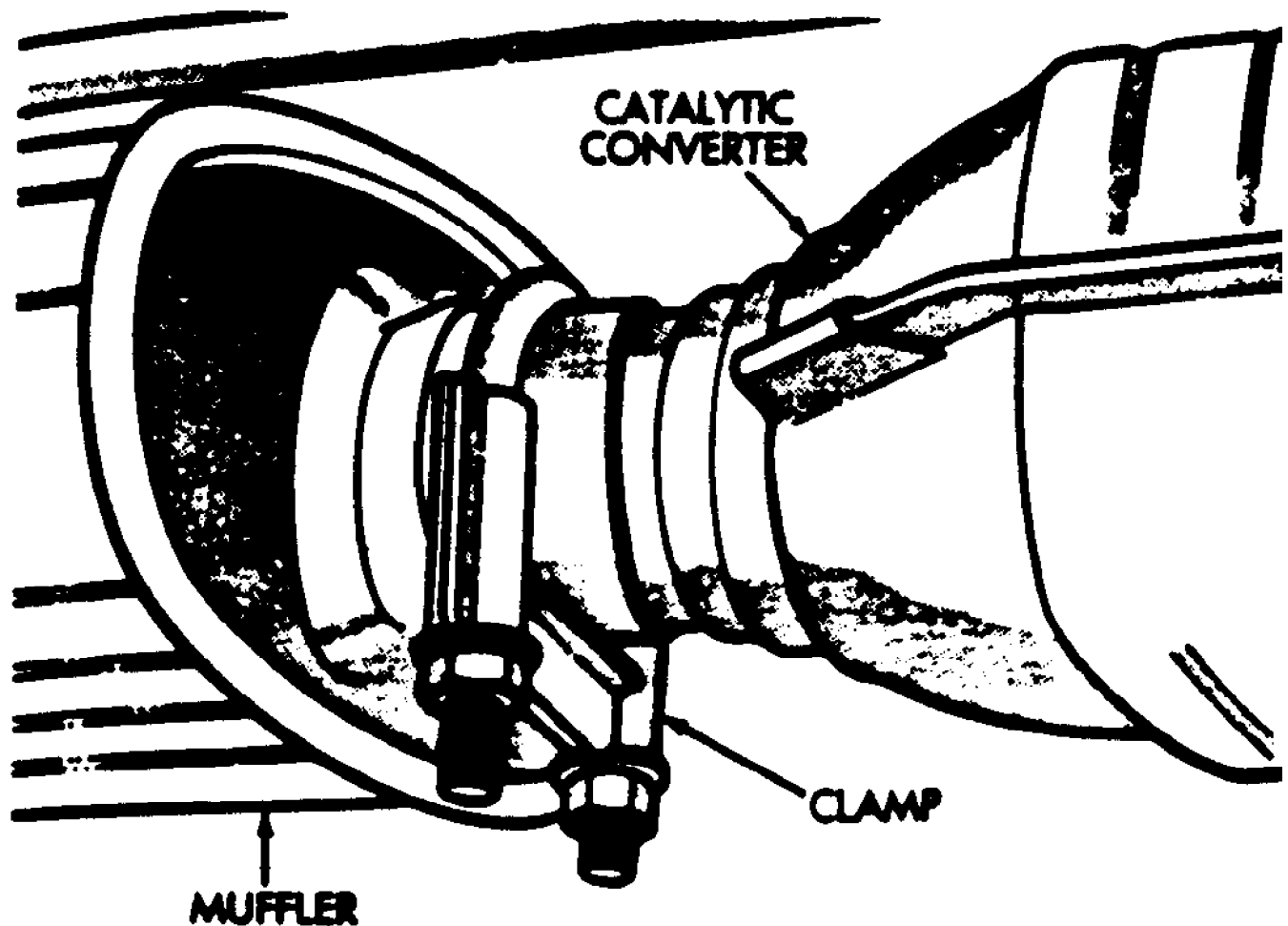


**97H55548**

Fig. 3: Front U-Bolt Clamps and Muffler Connections (YJ Vehicles)

5. While the metal is still cherry red, twist the muffler assembly back and forth to separate it from the converter.

6. Disconnect the front exhaust pipe from the catalytic converter. If necessary, heat the pipe connection as described above.
7. Connect the supplied catalytic converter to the front exhaust pipe. Use one of the supplied clamps and tighten the nuts to 45 ft-lbs (61 N.m).
8. Install the muffler on to the catalytic converter until the alignment tab is inserted into the alignment slot.
9. Install and tighten the new exhaust pipe clamp, at the muffler to converter connection, to 45 ft-lbs (61 Nm).



**97155549**

Fig. 4: Rear U-Bolt Clamps and Muffler Connections

10. On Wrangler (YJ) vehicles:  
Install the skid plate.

11. Lower the vehicle.

#### B. INSTALL RECALL COMPLETION LABEL

1. With a ball point pen, print your dealer code (5 digits) on the

supplied Recall Completion Label.

2. Peel the label from its backing and apply it near the Vehicle Emissions Control Information Label on the underside of the hood.

### C. COMPLETE PROOF OF CORRECTION FORM

1. Complete a Vehicle Emission Recall Proof of Correction Form and supply it to the vehicle owner.

### COMPLETION REPORTING AND REIMBURSEMENT

Claims for vehicles which have been serviced must be submitted on the DIAL System Claims submitted will be used by Chrysler to record recall service completions and provide dealer payments.

Use the following labor operation number and time allowance:

	Labor Operation Number	Time Allowance
Replace Catalytic Converter .....	11680182	0.7 Hours

Add the cost of the recall parts package plus applicable dealer allowance to your claim.

### PARTS RETURN

Removed catalytic converters must be returned to the Warranty Material Return Center.

NOTE: See Warranty Policy and Procedure Manual, Chapter 6, Subsection H for complete recall claim processing and material return instructions.

### VEHICLE NOT AVAILABLE

If a vehicle is not available for service for a known reason, let us know by filling out the pre-addressed Vehicle Disposition Form portion of the Owner Notification Form, or describe the reason on a postcard and mail to:

Chrysler Corporation  
CIMS 482-00-85  
800 Chrysler Drive East  
Auburn Hills, Michigan 48326-2757

Following the above procedures will expedite the processing of your claim.

If you have any questions or need assistance in completing this action, please contact your Zone Service Office.

Customer Services Field Operations  
Chrysler Corporation

### CUSTOMER NOTIFICATION LETTER

Dear Jeep Vehicle Owner:

It has been determined that some 1991 through 1995 Jeep, Cherokee, Comanche and Wrangler vehicles equipped with a 2.5L engine, may be in violation of California Emissions Standards.

The Problem is... The catalytic converter on your Jeep vehicle (identified by the Vehicle Identification Number on the enclosed form), may be susceptible to failure. Failure of the catalytic converter could result in hydrocarbon (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) emission levels above the allowable limits, which were established to protect the public health from the dangers of air pollution. HC emissions consist of unburned fuel that is released into the atmosphere. HC in combination with NOx in the presence of sunlight, can cause the formation of ozone. CO emissions are formed by the incomplete combustion of fuel. These pollutants are the primary components of smog.

What Chrysler and your dealer will do... Chrysler will repair your vehicle free of charge (parts and labor). To do this, your dealer will replace the catalytic converter. The service will take about one hour but additional time may be required depending on how service work is scheduled and processed.

What you must do... \* Simply contact your Jeep dealer to schedule a service appointment. Ask the dealer to hold parts for your vehicle or order them prior to your appointment.

\* Bring the enclosed Owner Notification Form with you to your dealer. It tells the dealer what service is required for your vehicle.

If you don't get this done... The State of California requires the completion of emission recall repairs prior to vehicle registration renewal. In addition, the State requires that every vehicle must pass an emission test (SMOG Check) every two years and before it is sold. Without the free service we are providing, your vehicle may be more likely to fail this test and require that you make costly repairs.

Further, in order to ensure your full protection under the emission warranty provisions, it is recommended that you have your vehicle serviced as soon as possible. Failure to do so could be determined as lack of proper maintenance of your vehicle.

How the state knows that the recall has been performed... State of California regulations require Chrysler to provide the Department of Motor Vehicles with a record of all vehicles which have not had the recall service performed. If your vehicle is not on this list, the state will know that the recall has been completed.



Your dealer will provide you with a Vehicle Emission Recall Proof of Correction Form after the recall service is completed. Be sure to save this form since the California Department of Motor Vehicles may require that you supply it as proof of recall completion.

If you need help... If you have trouble getting your vehicle repaired, please call the Chrysler Customer Center, toll free, at 1-800-853-1403. A representative will assist you in getting your vehicle repaired.

We are sorry for any inconvenience, but trust you understand our interest in clean air and in your continued satisfaction with our products. Thanks for your attention to this important matter.

Customer Services Field Operations  
Chrysler Corporation

## **RIDING HEIGHT ADJUSTMENT**

1993 Jeep Cherokee

1993 WHEEL ALIGNMENT

Chrysler Corp. Riding Height Adjustment

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### **RIDING HEIGHT ADJUSTMENT**

Before adjusting alignment, check riding height. Riding height must be checked with vehicle on level floor and tires properly inflated. Bounce vehicle several times and allow suspension to settle. Visually inspect vehicle for signs of abnormal height from front to rear or side to side. Check passenger and luggage compartments for extra heavy items and remove if present. If riding height difference from side to side is more than 1" (25.4 mm), check all suspension components and repair or replace as necessary.

# **99V340000: ROTOR REPLACEMENT**

1993 Jeep Cherokee

NHTSA RECALL BULLETIN

## **VEHICLE DESCRIPTION**

Model(s) :	1992 Jeep Cherokee
	1993 Jeep Cherokee
	1993 Jeep Grand Wagoneer
	1994 Jeep Cherokee
	1994 Jeep Grand Cherokee
	1995 Jeep Cherokee
	1995 Jeep Grand Cherokee
Campaign No:	99V340000
Mfg. Campaign No:	747
Number of Affected Vehicles:	334047

Passenger and multi-purpose vehicles originally sold in (or are currently registered in) the states of Connecticut, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, or Wisconsin, and the District Of Columbia.

## **DESCRIPTION OF DEFECT**

The front disc brake rotors can experience severe corrosion if operated for an extensive period in the "salt belt." if the rotors are not replaced, the corrosion can eventually compromise the structural integrity of the stamped steel center hub section of the rotor.

## **CONSEQUENCE OF DEFECT**

The reduced strength can allow the cast iron wear surface to separate from the hub, reducing the brake effectiveness of the vehicle.

## **CORRECTIVE ACTION**

Dealers will replace these rotors with rotors that are coated with a corrosion protection.

## **OWNER NOTIFICATION**

Owner notification began December 20, 1999. Owners who take their vehicles to an authorized dealer on an agreed upon service date and do not receive the free remedy within a reasonable time should contact daimlerchrysler at 1-800-992-1997. Also contact the National Highway Traffic Safety Administration's Auto Safety Hotline at 1-888-dash-2-dot (1-888-327-4236).

## **ADDITIONAL INFORMATION**

The National Highway Traffic Safety Administration operates Monday through Friday from 8:00 AM to 4:00 PM, Eastern Time. For more information call (800) 424-9393 or (202) 366-0123. For the hearing impaired, call (800) 424-9153.



# SCHEDULED SERVICES

## 1993 Jeep Cherokee

1989-96 MAINTENANCE  
Jeep Maintenance & Service Intervals

Jeep; Cherokee (1989-96),  
Wagoneer (1989-90)

### \* PLEASE READ THIS FIRST \*

- NOTE: All SERVICE SCHEDULES are listed for normal service vehicles. If vehicle is operated under severe service conditions, see SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES) for items requiring additional maintenance.
- NOTE: This article contains scheduled maintenance service information. Fluid types and capacities listed with each service in this article are only those necessary to perform that scheduled service. For specifications pertaining to fluid capacities for the entire vehicle, fuse and circuit breaker identification, wheel and tire size, battery type, warranty information, or model identification refer to the MAINTENANCE INFORMATION article in this section.

## CAUTIONS & WARNINGS

### SUPPLEMENTAL RESTRAINT SYSTEM (AIR BAG) (1995-96 Models)

- NOTE: See the AIR BAGS article in the ACCESSORIES/SAFETY EQUIPMENT Section.
- Modifications or improper maintenance, including incorrect removal and installation of the Supplemental Restraint System (SRS), can adversely affect system performance. DO NOT cover, obstruct or change the steering wheel horn pad in any way, as such action could cause improper function of the system. Use only plain water when cleaning the horn pad. Solvents or cleaners could adversely affect the air bag cover and cause improper deployment of the system.
- WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all warnings and service precautions. See appropriate AIR BAGS article in ACCESSORIES/SAFETY EQUIPMENT.
- WARNING: The Air Bag System installed on 1995 Cherokee models is a sensitive, complex MECHANICAL unit. Before attempting to remove or install the airbag system or related steering wheel and steering column components you MUST FIRST DISARM the AIR BAG firing mechanism. Failure to follow these procedures could result in accidental deployment and personal injury.
- WARNING: The air bag module inflator/sensor assembly contains sodium azide and potassium nitrate. These materials are poisonous and extremely flammable. Contact with acid, water or heavy metals may produce harmful & irritating gases or combustible compounds. DO NOT attempt to dismantle the module or tamper with its arming lever. DO NOT attempt puncture, incinerate, or bring into contact with electricity. DO NOT store at temperatures exceeding 200° F.
- WARNING: Replace airbag system components with parts specified in the

Chrysler Mopar parts catalog only. DO NOT mix components in this mechanically-fired airbag with components from ANY electrically-fired airbag system.

**WARNING:** The fasteners, screws and bolts used in this air bag system have a special coating on them and are specifically designed for use with this air bag system. DO NOT use any kind of substitute.

**CAUTION:** Disconnect negative battery cable before servicing any air bag system, steering column or passenger side dash component. After any repair, turn ignition key to the ON position from passenger's side of vehicle in case of accidental air bag inflation

## **AIR CONDITIONING MAINTENANCE**

**WARNING:** NEVER add A/C refrigerant to correct a non-cooling problem unless pressure gauges are connected to the system by a certified technician. Lack of cooling may be caused by a restriction, therefore adding refrigerant can cause a dangerous pressure rise.

## **AIR CONDITIONING SERVICING (1994-96 Models)**

**CAUTION:** Avoid breathing R-134a refrigerant and PAG lubricant vapors, exposure may irritate eyes, nose and throat. To remove R-134a from system use R-134a recycling equipment that meets SAE J2210 specifications. If accidental system discharge occurs, ventilate work area before resuming service.

**WARNING:** R-134a service equipment or vehicle A/C systems SHOULD NOT be pressure tested or leak tested with compressed air. Some mixtures of air/R134a have shown to be combustible at elevated pressures. These mixtures are dangerous and may cause fire and/or explosions. See AIR CONDITIONING SERVICE article in GENERAL INFORMATION section.

## **ANTI-LOCK BRAKE SYSTEM (If Equipped)**

The anti-lock brake system contains electronic equipment that can be susceptible to interference caused by improperly installed or high output radio transmitting equipment. Since this interference could cause the possible loss of the anti-lock braking capability, such equipment should be installed by qualified professionals.

On models equipped with anti-lock brake systems, ALWAYS observe the following cautions:

- \* DO NOT attempt to bleed hydraulic system without first referring to the appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES Section.
- \* DO NOT mix tire sizes. As long as tires remain close to the original diameter, increasing the width is acceptable. Rolling diameter must be identical for all 4 tires. Some manufacturers recommend tires of the same brand, style and type. Failure to follow this precaution may cause inaccurate wheel speed readings.
- \* Use ONLY recommended brake fluids. DO NOT use silicone brake fluids in an ABS-equipped vehicle.

## **BATTERY WARNING**

**WARNING:** When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section.

## **REPLACING BLOWN FUSES**

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

## **BRAKE PAD WEAR INDICATOR**

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

## **BRAKE FLUID MAINTENANCE**

**CAUTION:** Any time a hydraulic brake part is removed and/or replaced, the brake system **MUST BE** flushed. For more information regarding brake maintenance refer to BRAKE SYSTEM article.

## **BRAKE WARNING LIGHT**

**CAUTION:** If BRAKE warning light is on with parking brake disengaged and engine running, there may be a problem in the hydraulic brake system. Braking effort, brake pedal travel and stopping distances may increase.

## **CATALYTIC CONVERTER**

To prevent catalytic converter overheating, **DO NOT** allow engine to idle for more than 20 minutes.

## **COOLANT (PROPYLENE-GLYCOL FORMULATIONS)**

To avoid possible damage to vehicle use only ethylene-glycol based coolants with a mixture ratio from 44-68% anti-freeze. **DO NOT** use 100% anti-freeze as it will cause the formation of cooling system deposits. This results in coolant temperatures of over 300° F (149°C) which can melt plastics. 100% anti-freeze has a freeze point of only -8° F (-22°C).

**CAUTION:** Propylene-Glycol Mixtures has a smaller temperature range than Etylene-Gylcol. The temperature ranges (freeze-boil) of a 50/50 Anti-Freeze/Water Mixtures are:  
Propylene-Glycol    -26° F (-32°C) - 257° F (125°C)  
Ethylene-Glycol    -35° F (-37°C) - 263° F (128°C).

**CAUTION:** Propylene-Glycol/Ethylene-Glycol Mixtures can cause the destabilization of various corrosion inhibitors. Also Propylene-Glycol/Ethylene-Glycol has a different specific gravity than Ethylene-Glycol coolant, which will result in inaccurate freeze point calculations.

## **COMMAND-TRAC (4WD)**

**CAUTION:** NEVER operate a Command-Trac vehicle in 4WD on dry,

hard-surfaced roads for a sustained period. Use 4L only when needed for added pulling power. Operating vehicle in 4WD mode on such roads will cause stress and possible damage to components, as well as make shifting difficult. To reduce shifting effort, drive vehicle in Reverse for a few feet, or drive off hard-surfaced road momentarily to allow tire slippage.

## **FRONT AND REAR DIFFERENTIALS (4WD)**

CAUTION: DO NOT use water, steam, kerosene or gasoline for flushing a differential. ONLY use a flushing oil.

## **TRAC-LOK DIFFERENTIALS (4WD)**

CAUTION: DO NOT flush a rear axle Trac-Lok differential. Trac-Lok differentials may be cleaned only by disassembling the unit and wiping the components with clean, lint-free cloth.

CAUTION: NEVER attempt to engage Low range when vehicle is moving faster than 2-3 MPH, as transfer case damage may result.

## **GASOLINE CONTAINING ALCOHOL**

CAUTION: Exclusive use of gasohol is not recommended. Vehicle test results have shown that significant fuel system corrosion can result when gasohol is used exclusively.

## **HALOGEN BULBS**

WARNING: Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

## **METHANOL GASOLINE**

CAUTION: Fuel that is more than 5% methanol should not be used in this vehicle. It can corrode metal parts in the fuel system, and damage plastic and rubber parts. Even at 5% methanol or less, solvents and corrosion preventers must be used with this fuel to avoid these problems.

## **OIL FILTER**

CAUTION: The engine oil filter mount has metric threads. Use of a filter with improper threads can result in oil leakage and possible engine damage. Look for M20 x 1.5 symbol on the filter.

## **RADIATOR CAP**

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

## **RADIATOR FAN**

WARNING: Keep hands away from radiator fan.



## **WHEEL & TIRE WARNINGS**

CAUTION: Replacing original tires with different size tires may result in false speedometer and odometer indications. Check with dealer before using different size tires on vehicle.

CAUTION: Ensure all 4 wheels on vehicle have same tire size, type and circumference in order to provide proper vehicle handling. DO NOT mix radial-ply with bias-ply or bias-belted tires. On 4WD vehicles, if tire size, type and circumference on all 4 wheels are not the same, gear shifting will be adversely affected and can damage transfer case.

CAUTION: Temporary-use spare tires are for emergency use only. DO NOT drive vehicle faster than 50 MPH or more than 100 miles when using spare tire. DO NOT operate vehicle in 4WD mode when using spare tire, as damage to transfer case can result. Temporary-use spare tires have a total tread life of 3,000 miles.

## **TRANSFER CASE**

WARNING: DO NOT leave vehicle unattended with transfer case in Neutral without fully applying parking brake. Transfer case Neutral position disengages both axles and will allow vehicle to move regardless of transmission position.

CAUTION: Never attempt to engage Low range when vehicle is moving faster than 2-3 MPH (3-5 KM/H). Transfer case damage may result.

CAUTION: DO NOT operate vehicle in Low range for extended periods on dry, hard surfaced roads. Damage to components and hard shifting may result.

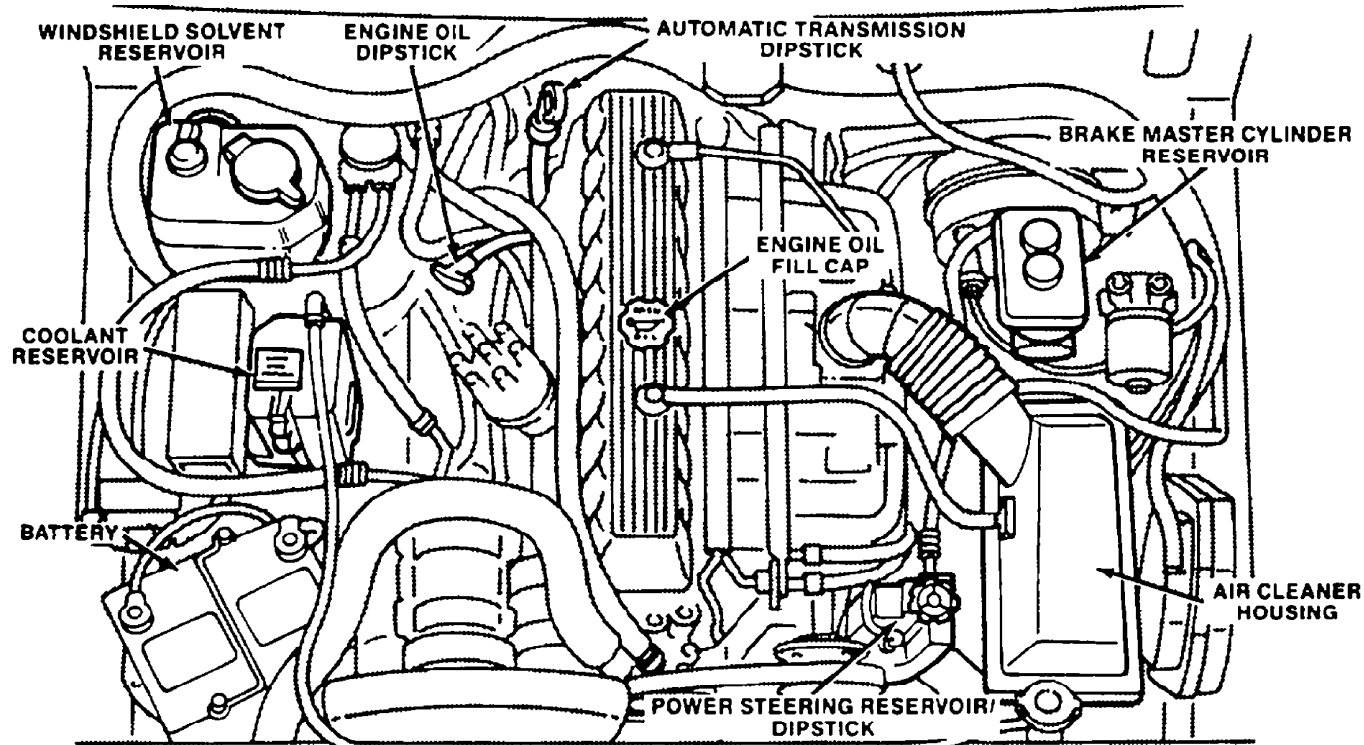
## **SPARK PLUG REPLACEMENT INTERVALS**

Spark plug replacement intervals, if given, are for Original Equipment Manufacturer (OEM) installed or specified plugs. If vehicle is equipped with platinum type or other non-OEM type spark plugs, follow replacement interval specified by spark plug manufacturer.

## **OXYGEN SENSOR**

If vehicle is equipped with an oxygen sensor, replace at 82,500 miles or when the emissions maintenance reminder light remains on continuously with the key in the ON position, whichever occurs first.

## **SERVICE POINT LOCATIONS**



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Fig. 1: Service Point Locations (Typical)  
Courtesy of Chrysler Corp.

## ADDITIONAL SERVICE INFORMATION

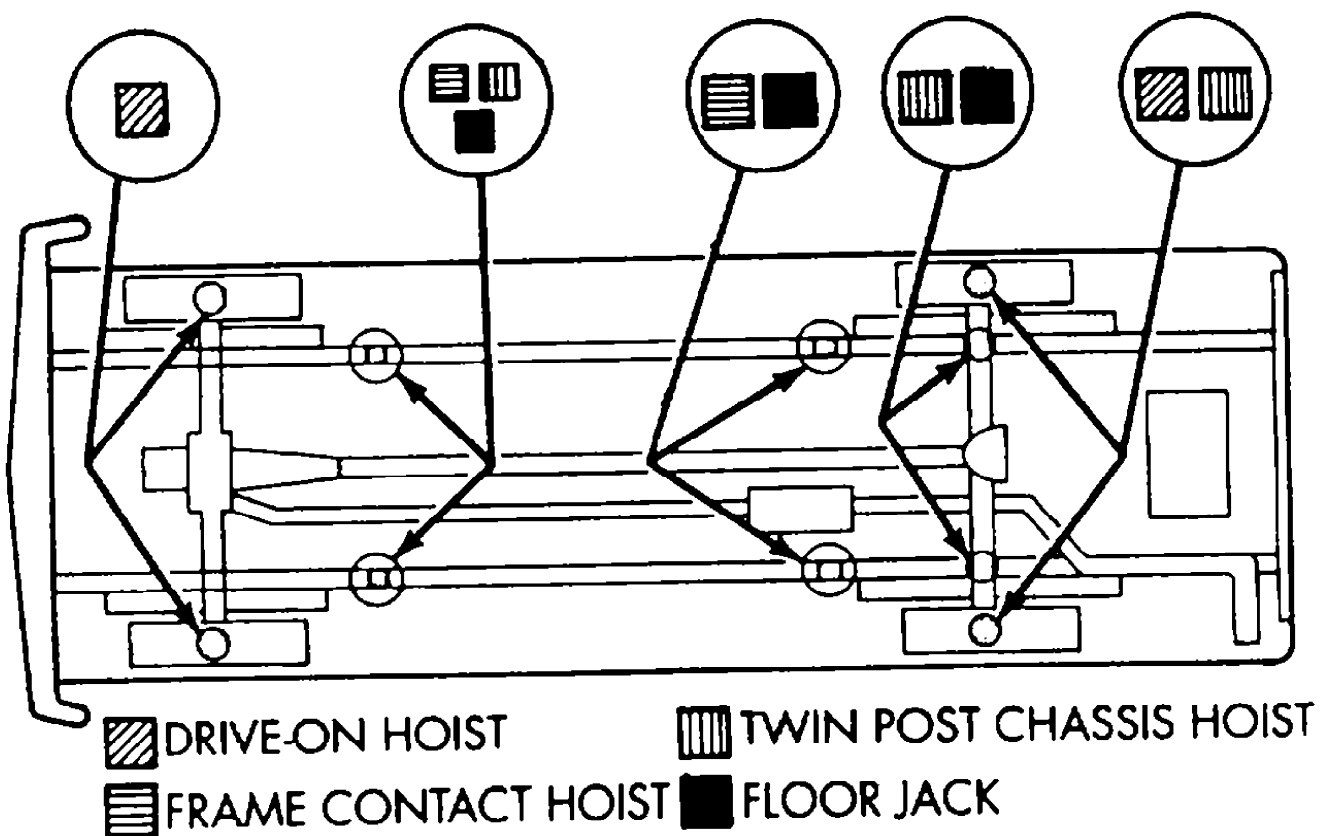
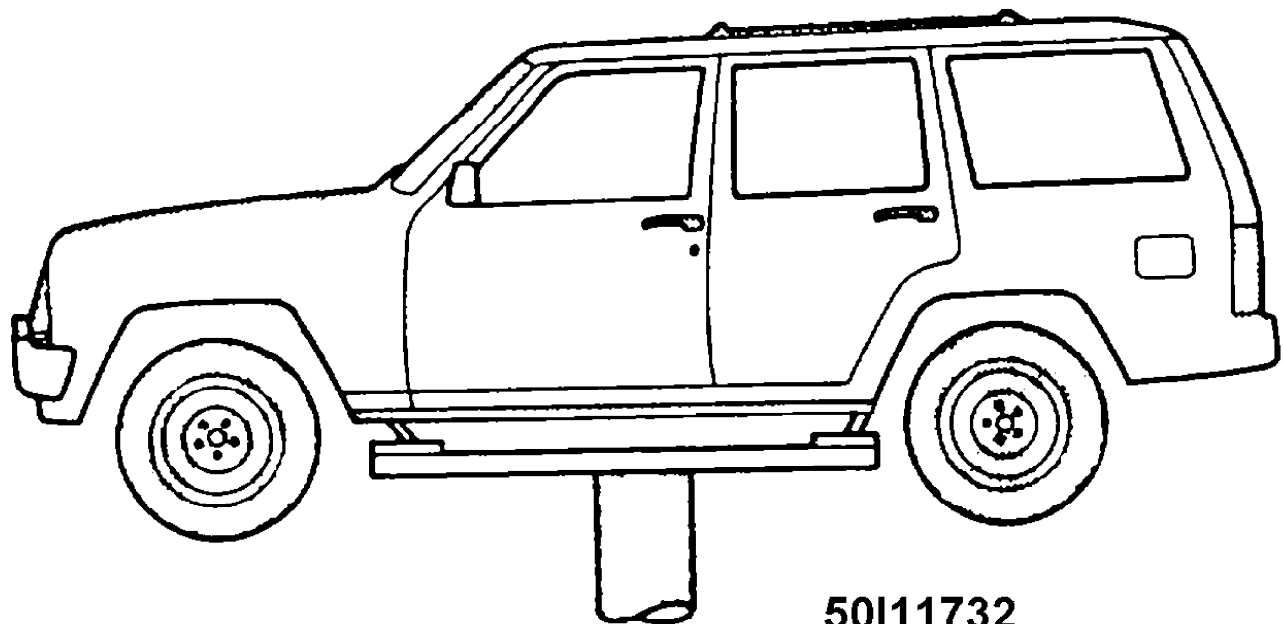
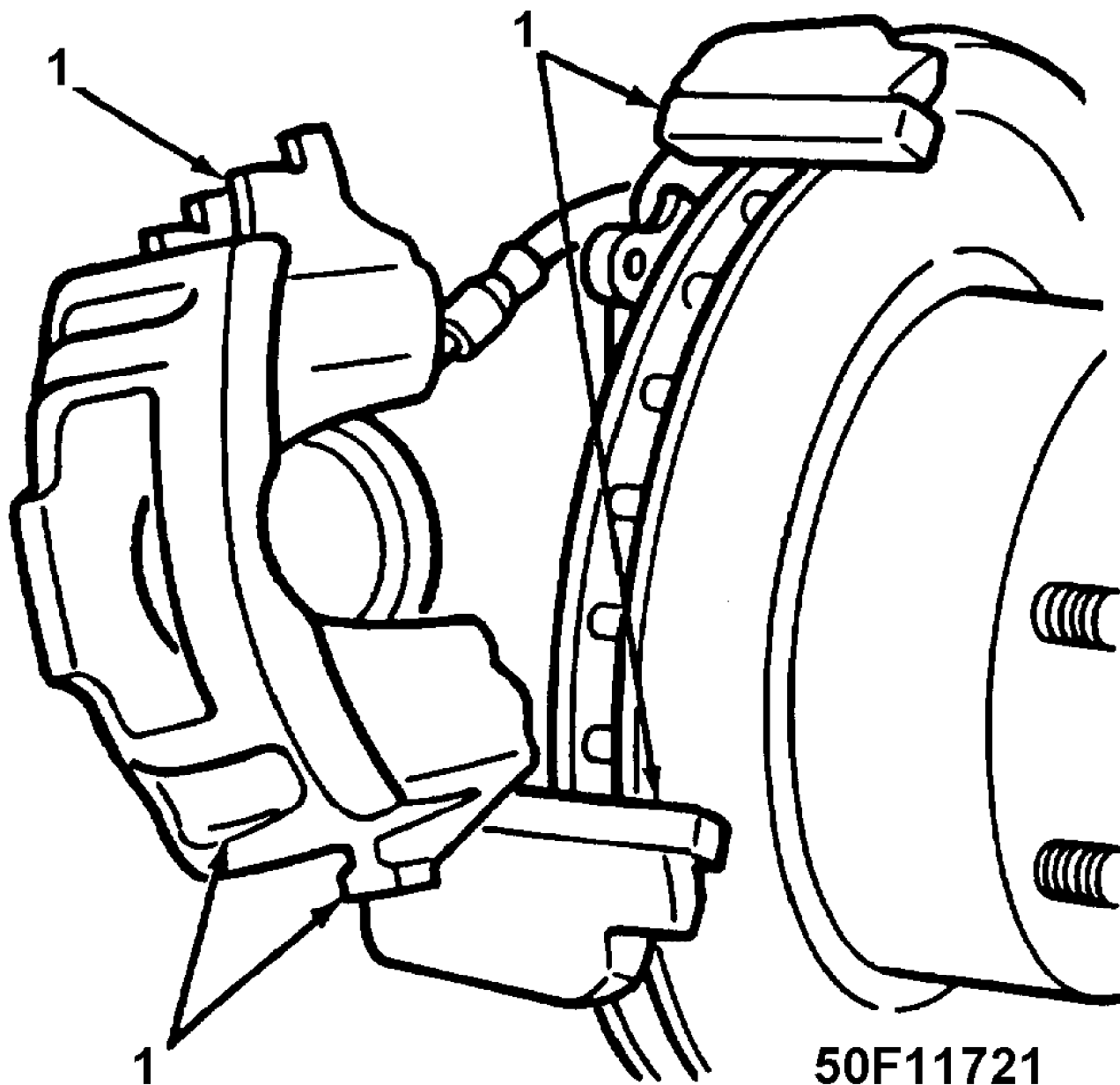


Fig. 2: Hoist Lift Point Locations  
 Courtesy of Chrysler Corp.

NOTE: For more information regarding jacking and hoisting refer to the JACKING & HOISTING article in the

WHEEL ALIGNMENT section.

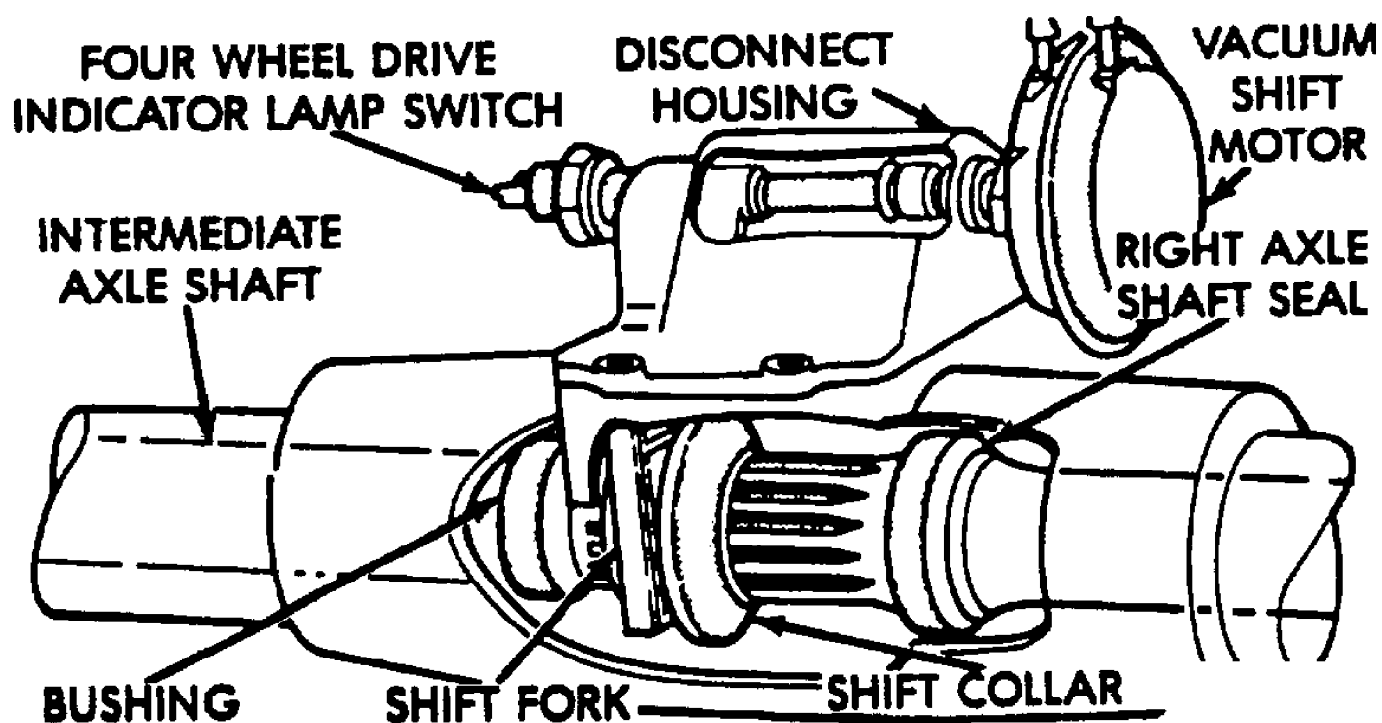


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## 1. LUBRICATION POINTS

Fig. 3: Brake Caliper Lubrication Points  
Courtesy of Chrysler Corp.

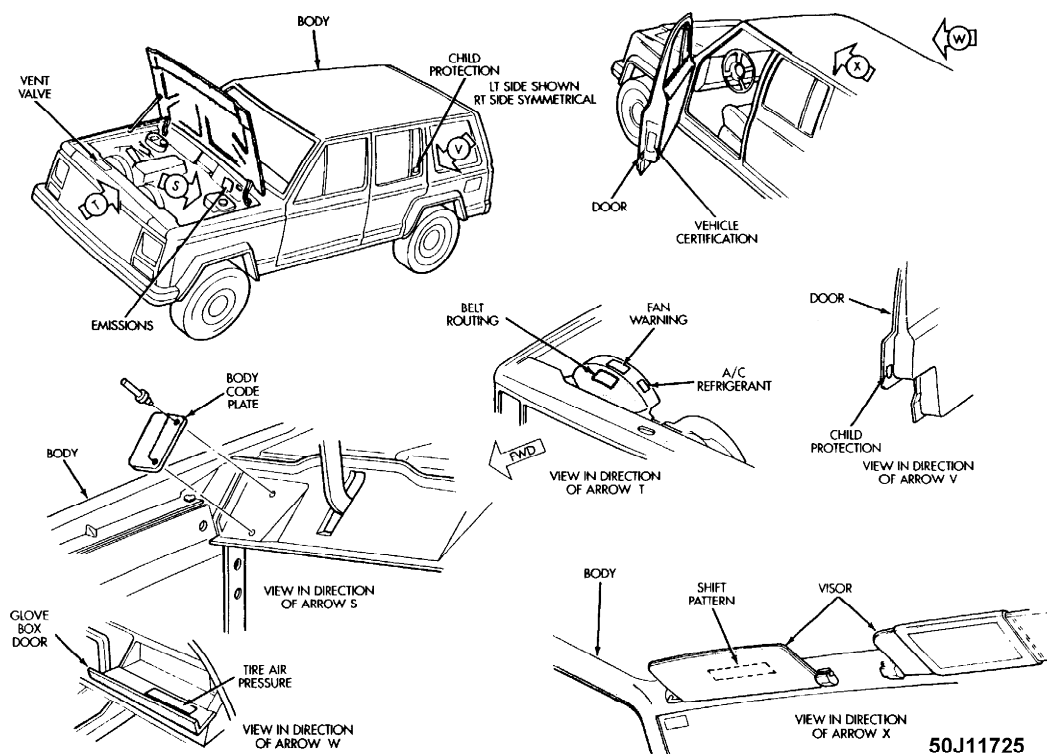
NOTE: For more information regarding brake maintenance refer to the BRAKE SYSTEM article in the BRAKES section.



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Fig. 4: Front Disconnect Housing Lubrication Point  
Courtesy of Chrysler Corp.

#### IDENTIFICATION LABEL LOCATIONS



#### VEHICLE, LABELS AND PLATES

Fig. 5: Identification Label Locations  
Courtesy of Chrysler Corp.

### SEVERE & NORMAL SERVICE DEFINITIONS

NOTE: Use the Severe Service schedule if the vehicle to be serviced is operated under ANY (one or more) of these conditions:

Service is recommended at mileage intervals based on vehicle operation. Normal Service and Severe Service are based on the following primary operating conditions:

#### Severe Service

- \* Short Trips (About 15 Miles)
- \* Desert Or Cold Climate Operation
- \* Towing Or Heavily Loaded
- \* Severe Dust Conditions
- \* Hot Weather, Stop-And-Go Driving
- \* Sustained High Speed Driving
- \* Extensive Idling Conditions (Taxi Or Delivery-Type Service)
- \* Driving Off-Road Or In Salty Or Sandy Areas
- \* Operation In Water

#### Normal Service

- \* Driven More Than 10 Miles Daily
- \* No Severe Service Operating Conditions

### SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES)

NOTE: The following services are to be performed on vehicles

subjected to severe service. See SEVERE & NORMAL SERVICE DEFINITIONS. This service is to be performed in addition to the normal services listed in the NORMAL MAINTENANCE SERVICE SCHEDULES.

SEVERE SERVICE CONDITIONS/ACTIONS TABLE

Condition	Action	Item	Perform Every (1)
Short Trips (About 15 Miles)	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
Desert Or Cold Climate Operation	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
Towing Or Heavily Loaded	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles

	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
Severe Dust Conditions	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
Hot Weather, Stop-And-Go Driving	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
Sustained High Speed Driving	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months



	Replace	M/T Oil	18,000 Miles
Extensive Idling Conditions (Taxi Or Delivery-Type Service)	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
Driving Off-Road	Replace	4WD: Engine Oil	50 Hours Of Operation
	Service	Lubricate Front Axle, Steering & Clutch Linkages, Axle & Driveshaft U	1,000 Miles
	Service	Lubricate A/T External Controls	1,000 Miles
	Inspect	Front Wheel Bearings	1,000 Miles
	Inspect	Disc & Drum Brake Systems, Hoses & Lines	1,000 Miles
	Service	Lubricate Brake Caliper Slide Rails	1,000 Miles
	Inspect	Exhaust System For Leaks, Damage, Or Loose Parts	1,000 Miles
	Service	Remove Any Foreign Material Trapped By Exhaust Shielding	1,000 Miles

	Service	Lubricate Clutch Release Lever Pivot	1,000 Miles
	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
	Replace	M/T Oil	18,000 Miles
Operation In Water	Service	Lubricate Front Axle, Steering & Clutch Linkages, Axle & Driveshaft U	Daily
	Service	Lubricate A/T External Controls	Daily
	Inspect	Front Wheel Bearings	Daily
	Inspect	Disc & Drum Brake Systems, Hoses & Lines	Daily
	Service	Lubricate Brake Caliper Slide Rails	Daily
	Inspect	Exhaust System For Leaks, Damage, Or Loose Parts	Daily
	Service	Remove Any Foreign Material Trapped By Exhaust Shielding	Daily

	Service	Lubricate Clutch Release Lever Pivot	Daily
	Replace	Engine Oil	3,000 Miles or 3 Months
	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
	Replace	Engine Oil	3,000 Miles or 3 Months
Driving In Salty Or Sandy Areas	Service	Lubricate Propeller Shaft Universal Joints If Equipped With Fittings	3,000 Miles
	Replace	Engine Oil Filter	6,000 Miles or 6 Months
	Replace	A/T Fluid	12,000 Miles
	Replace	Front & Rear Axle Fluid	12,000 Miles
	Replace	M/T Oil	18,000 Miles
	Replace	Engine Oil	3,000 Miles or 3 Months
(1) - Perform these services at the mileage or number of months (since the last time), whichever comes first.			

## NORMAL MAINTENANCE SERVICE SCHEDULES

CAUTION: The following service schedules refer to vehicles driven under normal operating conditions. For vehicles driven under severe conditions, additional services may be necessary. See SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES) above in this article for additional service requirements.

### 7,500 MILE (12,000 KM) SERVICE

7,500 MILE (12,000 KM) SERVICE

Service Or Inspect	
	Check Fluid Levels
	Inspect Coolant Hoses and Clamps
	Inspect Brake System
	Inspect Exhaust System
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Engine Oil (2)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Includes Filter.

### 15,000 MILE (24,000 KM) SERVICE

#### 15,000 MILE (24,000 KM) SERVICE

Service Or Inspect
Verify Last Major Service Was Performed
Check Fluid Levels
Check Cooling System Hoses and Clamps
Check Coolant Strength
Check Exhaust System & Heat Shielding
Clean Battery and Battery Terminals
Accessory Drive Belts
Inspect Brake System
Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
Inspect C/V Joint boots (4WD)
Check Drive Shaft Seals
Lubricate Ball Joints, Steering Linkage & Suspension
Lube Drive Shaft U-Joints and Slip Splines
Lube Front Axle Drive Joint and Pivot Bearings (4WD)

	Check/Lube Manual Steering Gear
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
Replace	
	Engine Oil
	Oil Filter
Lubrication Specifications	
Application	
Specification	
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Engine Oil (5)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.	
(2) - Includes Filter.	

## 22,500 MILE (36,000 KM) SERVICE

### 22,500 MILE (36,000 KM) SERVICE

Service Or Inspect
Verify Last Major Service Was Performed
Check Fluid Levels
Check Cooling System Hoses and Clamps
Check Exhaust System & Heat Shielding
Inspect Brake Hoses
Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
Inspect C/V Joint boots (4WD)
Check Drive Shaft Seals
Lubricate Ball Joints, Steering Linkage & Suspension
Lube Drive Shaft U-Joints and Slip Splines
Lube Front Axle Drive Joint and Pivot Bearings (4WD)
Check/Lube Manual Steering Gear
Lube Parking Brake Ratio Lever Pivot
Lube Manual Gearshift Control (4WD Transfer Case)

	Inspect Front Brake Pads & Rotors
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
	Replace
	Engine Oil
	Oil Filter
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-II/ Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-II/ ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)
(1) - DO NOT use Dexron-II ATF, Clutch chatter can result.	
(2) - SAE 10W-30 SH/CD is preferred.	
(3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.	
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.	
(5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.	
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.	
(6) - Use low pressure grease gun to prevent seal damage.	
(7) - Fill until lubricant squeezes out from the base of seals.	



(8) - Fill ball joint until seal starts to swell.	
Fluid Capacities	
Application	(1) Quantity
Engine Oil (5)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.	
(2) - Includes Filter.	

### 30,000 MILE (48,000 KM) SERVICE

#### 30,000 MILE (48,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Exhaust System & Heat Shielding
	Clean Battery and Battery Terminals
	Inspect/Adjust Drive Belt Tension (4.0L)
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Suspension Bushings, Springs, Arms & Rear Jounce Bumpers
	Parking Brake System
	Lubricate Body Components
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	

Engine Oil	
Oil Filter	
Spark Plugs	
Air Filter Element	
Automatic Transmission Fluid, Filter and Adjust Bands	
Transfer Case Fluid	
Front & Rear Axle Fluid	
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-II/ Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-II/ ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)
(1) - DO NOT use Dexron-II ATF, Clutch chatter can result.	
(2) - SAE 10W-30 SH/CD is preferred.	
(3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.	
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.	
(5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.	
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.	
(6) - Use low pressure grease gun to prevent seal damage.	
(7) - Fill until lubricant squeezes out from the base of seals.	
(8) - Fill ball joint until seal starts to swell.	
Fluid Capacities	

Application	(1) Quantity
Automatic Transmission (2)	
30RH (3-Speed)	
Fluid Change .....	4.0 Qts. (3.8L)
Overhaul (Dry Fill) .....	8.75 Qts. (8.2L)
AW4 (4-Speed)	
Fluid Change .....	2.0 Qts. (1.7L)
Overhaul (Dry Fill) .....	8.5 Qts. (8.0L)
Cooling System	
2.5L (3) .....	10.0 Qts. (9.5L)
4.0L (4) .....	12.0 Qts. (11.4L)
Engine Oil (5)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
Manual Transmission (6)	
AX4 (4-Speed AISIN) .....	7.4 Pts. (3.5L)
T4 (Borg-Warner) .....	3.9 Pts. (1.8L)
AX5 (5-Speed AISIN)	
2.5L (2WD) .....	7.0 Pts. (3.5L)
2.5L (4X4) .....	6.6 Pts. (3.2L)
T5 (Borg-Warner) .....	4.5 Pts. (2.1L)
AX15 (5-Speed AISIN)	
4.0L (2WD) .....	6.4 Pts. (3.1L)
4.0L (4X4) .....	6.5 Pts. (3.15L)
Transfer Case	
Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)
Drive Axles (6)	
Front Axle (Model 30)	
Command-Trac (Disconnect) .....	3.76 Pts. (1.65L)
(Disconnect Housing) (7) .....	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect) .....	3.13 Pts. (1.5L)
Rear Axle	
1989-94 (8) .....	2.5 Pts. (1.2L)
1995-96	
Model 35 (8) .....	3.5 Pts. (1.6L)
8-1/4" (8) .....	4.4 Pts. (2.1L)
(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level. (2) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level. (3) - Includes 2.3 qts. (2.2L) for coolant recovery bottle. (4) - Includes 1.0 qt. (0.9L) for coolant recovery bottle. (5) - Includes Filter. (6) - Fill to bottom edge of filler plug hole. (7) - Add 5 ozs. of gear lubricant through indicator switch hole. (8) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.	
Service Labor Times	
Application	(1) Hours
2.5L	
Automatic Transmission .....	4.2
Manual Transmission .....	2.4
4.0L	
Automatic Transmission .....	4.3
Manual Transmission .....	2.5

(1) - Add .6 hr. for vehicles equipped with 4WD.

### 37,500 MILE (60,000 KM) SERVICE

#### 37,500 MILE (60,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Inspect Brake System
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter
	Manual Transmission Fluid
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid

Manual Transmission .....	SAE 75W-90 API GL-5
Manual Steering Box .....	Multi-Purpose NLGI Grade 2EP
Power Steering Pump .....	Power Steering Fluid
Transfer Case .....	Dexron-II E ATF
Parking Brake Cable Guides .....	NLGI Grade 2, GC-LB
Brake Caliper Bushings .....	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins .....	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges .....	Light Engine Oil
Wheel Bearings .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7) ....	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8) .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip .....	Silicone Spray Lubricant
Wheel Lug Nut Torque .....	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Automatic Transmission (2)	
30RH (3-Speed)	
Fluid Change .....	4.0 Qts. (3.8L)
Overhaul (Dry Fill) .....	8.75 Qts. (8.2L)
AW4 (4-Speed)	
Fluid Change .....	2.0 Qts. (1.7L)
Overhaul (Dry Fill) .....	8.5 Qts. (8.0L)
Cooling System	
2.5L (3) .....	10.0 Qts. (9.5L)
4.0L (4) .....	12.0 Qts. (11.4L)
Engine Oil (5)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
Manual Transmission (6)	
AX4 (4-Speed AISIN) .....	7.4 Pts. (3.5L)
T4 (Borg-Warner) .....	3.9 Pts. (1.8L)
AX5 (5-Speed AISIN)	
2.5L (2WD) .....	7.0 Pts. (3.5L)
2.5L (4X4) .....	6.6 Pts. (3.2L)
T5 (Borg-Warner) .....	4.5 Pts. (2.1L)
AX15 (5-Speed AISIN)	
4.0L (2WD) .....	6.4 Pts. (3.1L)
4.0L (4X4) .....	6.5 Pts. (3.15L)
Transfer Case	
Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)
Drive Axles (6)	
Front Axle (Model 30)	
Command-Trac (Disconnect) .....	3.76 Pts. (1.65L)

(Disconnect Housing) (7)	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect)	3.13 Pts. (1.5L)
Rear Axle	
1989-94 (8)	2.5 Pts. (1.2L)
1995-96	
Model 35 (8)	3.5 Pts. (1.6L)
8-1/4" (8)	4.4 Pts. (2.1L)
(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.	
(2) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.	
(3) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.	
(4) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.	
(5) - Includes Filter.	
(6) - Fill to bottom edge of filler plug hole.	
(7) - Add 5 ozs. of gear lubricant through indicator switch hole.	
(8) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.	

## 45,000 MILE (72,000 KM) SERVICE

### 45,000 MILE (72,000 KM) SERVICE

Service Or Inspect
Verify Last Major Service Was Performed
Check Fluid Levels
Check Fuel Lines, Connections
Check Cooling System Hoses and Clamps
Check Coolant Strength
Clean Battery and Battery Terminals
Check Exhaust System & Heat Shielding
Check Operation of Horn, Wipers/Washers & All Exterior Lights
Inspect Condition of Wiper Blades
Check Headlight Alignment
Check Seat Belt Webbing and Release Mechanisms
Check Parking Brake Operation
Check Shift/Clutch Interlock Operation
Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
Inspect C/V Joint boots (4WD)
Check Drive Shaft Seals
Lubricate Ball Joints, Steering Linkage & Suspension
Lube Drive Shaft U-Joints and Slip Splines

Lube Front Axle Drive Joint and Pivot Bearings (4WD)
Check/Lube Manual Steering Gear
Lube Parking Brake Ratio Lever Pivot
Lube Manual Gearshift Control (4WD Transfer Case)
Inspect Front Brake Pads & Rotors
Inspect Rear Brake Linings & Drums
Inspect Brake System Hoses & Lines
Inspect Shocks for Leakage
Inspect Tire Wear Pattern
Lubricate Weatherstripping with Silicone
Lubricate Door Hinges
Lubricate Door Locks
Check Body Drain Holes
Rotate Tires and Adjust Air Pressure
Replace
Engine Oil
Oil Filter
Flush and Fill Engine Coolant, if not done in last 36 months
Lubrication Specifications

Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB

Drive Shaft U-Joints	.....	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	....	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	.....	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	.....	Silicone Spray Lubricant
Wheel Lug Nut Torque	.....	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Cooling System	
2.5L (2)	10.0 Qts. (9.5L)
4.0L (3)	12.0 Qts. (11.4L)
Engine Oil (4)	
2.5L	4.0 Qts. (3.8L)
4.0L	6.0 Qts. (5.7L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (3) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (4) - Includes Filter.

## 52,500 MILE (84,000 KM) SERVICE

### 52,500 MILE (84,000 KM) SERVICE

Service Or Inspect
Verify Last Major Service Was Performed
Check Fluid Levels
Check Fuel Lines, Connections
Check Cooling System Hoses and Clamps
Check Exhaust System & Heat Shielding
Inspect Brake System
Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
Inspect C/V Joint boots (4WD)
Check Drive Shaft Seals



	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Rotate Tires and Adjust Air Pressure (Including Spare)
	Replace
	Engine Oil
	Oil Filter
	Flush and Fill Engine Coolant, if not done in last 36 months
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)
(1) - DO NOT use Dexron-II ATF, Clutch chatter can result.	
(2) - SAE 10W-30 SH/CD is preferred.	
(3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.	
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.	
(5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.	
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.	
(6) - Use low pressure grease gun to prevent seal damage.	

- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Cooling System	
2.5L (2) .....	10.0 Qts. (9.5L)
4.0L (3) .....	12.0 Qts. (11.4L)
Engine Oil (4)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (3) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (4) - Includes Filter.

### 60,000 MILE (96,000 KM) SERVICE

#### 60,000 MILE (96,000 KM) SERVICE

Service Or Inspect
Verify Last Major Service Was Performed
Check Fluid Levels
Check Cooling System Hoses and Clamps
Check Coolant Strength
Check/Adjust Accessory Drive Belts
Ignition Timing
Clean EGR Passages (if equipped)
Check Exhaust System & Heat Shielding
Clean/Inspect Battery and Battery Terminals
Inspect Brake System
Inspect Exhaust System
Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
Inspect C/V Joint boots (4WD)
Check Drive Shaft Seals
Lubricate Ball Joints, Steering Linkage & Suspension
Lube Drive Shaft U-Joints and Slip Splines
Lube Front Axle Drive Joint and Pivot Bearings (4WD)
Check/Lube Manual Steering Gear

	Suspension Bushings, Springs, Arms & Rear Jounce Bumpers
	Parking Brake System
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
	Replace
	Engine Oil
	Oil Filter
	Spark Plugs
	Ignition Cables
	Distributor Cap and Rotor
	Air Filter Element
	EGR Valve & Tube (1989-92)
	Emission System Vacuum Hoses
	Vacuum Operated Emission Components (1989-92)
	PCV Valve (1)
	Drive Belt (V-Type) (2)
	Accessory Drive Belts
	Fuel Filter (In-Line)
	Flush and Fill Engine Coolant, if not done in last 24 months
	Automatic Transmission Fluid, Filter and Adjust Bands
	Transfer Case (Drain and Refill)
	Front & Rear Axle Fluid
(1) - Replacement is recommended by Chrysler at this time, but it is not required to maintain the warranty on the PCV valve. (2) - Check and replace as needed.	
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII

Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-II E ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Automatic Transmission (2)	
30RH (3-Speed)	
Fluid Change	4.0 Qts. (3.8L)
Overhaul (Dry Fill)	8.75 Qts. (8.2L)
AW4 (4-Speed)	
Fluid Change	2.0 Qts. (1.7L)
Overhaul (Dry Fill)	8.5 Qts. (8.0L)
Cooling System	
2.5L (3)	10.0 Qts. (9.5L)
4.0L (4)	12.0 Qts. (11.4L)
Engine Oil (5)	
2.5L	4.0 Qts. (3.8L)
4.0L	6.0 Qts. (5.7L)
Manual Transmission (6)	
AX4 (4-Speed AISIN)	7.4 Pts. (3.5L)
T4 (Borg-Warner)	3.9 Pts. (1.8L)
AX5 (5-Speed AISIN)	
2.5L (2WD)	7.0 Pts. (3.5L)
2.5L (4X4)	6.6 Pts. (3.2L)
T5 (Borg-Warner)	4.5 Pts. (2.1L)
AX15 (5-Speed AISIN)	
4.0L (2WD)	6.4 Pts. (3.1L)
4.0L (4X4)	6.5 Pts. (3.15L)
Transfer Case	

Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)
Drive Axles (6)	
Front Axle (Model 30)	
Command-Trac (Disconnect) .....	3.76 Pts. (1.65L)
(Disconnect Housing) (7) .....	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect) .....	3.13 Pts. (1.5L)
Rear Axle	
1989-94 (8) .....	2.5 Pts. (1.2L)
1995-96	
Model 35 (8) .....	3.5 Pts. (1.6L)
8-1/4" (8) .....	4.4 Pts. (2.1L)
(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.	
(2) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.	
(3) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.	
(4) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.	
(5) - Includes Filter.	
(6) - Fill to bottom edge of filler plug hole.	
(7) - Add 5 ozs. of gear lubricant through indicator switch hole.	
(8) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.	

#### Service Labor Times

Application	(1) Hours
1989-92	
2.5L	
Automatic Transmission .....	9.3
Manual Transmission .....	7.5
4.0L	
Automatic Transmission .....	10.1
Manual Transmission .....	8.3
1993-96	
2.5L	
Automatic Transmission .....	7.6
Manual Transmission .....	5.8
4.0L	
Automatic Transmission .....	7.8
Manual Transmission .....	6.0
(1) - Add .6 hour for vehicles equipped with 4WD.	

## 67,500 MILE (108,000 KM) SERVICE

### 67,500 MILE (108,000 KM) SERVICE

Service Or Inspect
Verify Last Major Service Was Performed
Check Fluid Levels
Check Cooling System Hoses and Clamps
Check Exhaust System & Heat Shielding
Inspect Underside of Vehicle (Bolts & Threaded Fasteners)

	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Lube Parking Brake Ratio Lever Pivot
	Lube Manual Gearshift Control (4WD Transfer Case)
	Inspect Front Brake Pads & Rotors
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
	Replace
	Engine Oil
	Oil Filter
	Lubrication Specifications
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB

Ball Joints (6) (8) ..... Multi-Purpose NLGI Grade 2EP, GC-LB  
Weatherstrip ..... Silicone Spray Lubricant  
Wheel Lug Nut Torque ..... 80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Cooling System	
2.5L (2) .....	10.0 Qts. (9.5L)
4.0L (3) .....	12.0 Qts. (11.4L)
Engine Oil (4)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level. (2) - Includes 2.3 qts. (2.2L) for coolant recovery bottle. (3) - Includes 1.0 qt. (0.9L) for coolant recovery bottle. (4) - Includes Filter.	

## 75,000 MILE (120,000 KM) SERVICE

### 75,000 MILE (120,000 KM) SERVICE

Service Or Inspect
Verify Last Major Service Was Performed
Check Fluid Levels
Check Fuel Lines, Connections
Check Cooling System Hoses and Clamps
Check Coolant Strength
Check Exhaust System & Heat Shielding
Clean Battery and Battery Terminals
Inspect Brake System
Check Operation of Horn, Wipers/Washers & All Exterior Lights
Inspect Condition of Wiper Blades

	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
	Replace
	Engine Oil
	Oil Filter
	Manual Transmission Fluid
	Flush and Fill Engine Coolant, if not done in last 24 months
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid



Transfer Case .....	Dexron-II E ATF
Parking Brake Cable Guides .....	NLGI Grade 2, GC-LB
Brake Caliper Bushings .....	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins .....	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges .....	Light Engine Oil
Wheel Bearings .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7) ....	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8) .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip .....	Silicone Spray Lubricant
Wheel Lug Nut Torque .....	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Automatic Transmission (2)	
30RH (3-Speed)	
Fluid Change .....	4.0 Qts. (3.8L)
Overhaul (Dry Fill) .....	8.75 Qts. (8.2L)
AW4 (4-Speed)	
Fluid Change .....	2.0 Qts. (1.7L)
Overhaul (Dry Fill) .....	8.5 Qts. (8.0L)
Cooling System	
2.5L (3) .....	10.0 Qts. (9.5L)
4.0L (4) .....	12.0 Qts. (11.4L)
Engine Oil (5)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
Manual Transmission (6)	
AX4 (4-Speed AISIN) .....	7.4 Pts. (3.5L)
T4 (Borg-Warner) .....	3.9 Pts. (1.8L)
AX5 (5-Speed AISIN)	
2.5L (2WD) .....	7.0 Pts. (3.5L)
2.5L (4X4) .....	6.6 Pts. (3.2L)
T5 (Borg-Warner) .....	4.5 Pts. (2.1L)
AX15 (5-Speed AISIN)	
4.0L (2WD) .....	6.4 Pts. (3.1L)
4.0L (4X4) .....	6.5 Pts. (3.15L)
Transfer Case	
Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)
Drive Axles (6)	
Front Axle (Model 30)	
Command-Trac (Disconnect) .....	3.76 Pts. (1.65L)
(Disconnect Housing) (7) .....	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect) .....	3.13 Pts. (1.5L)
Rear Axle	

1989-94 (8) .....	2.5 Pts. (1.2L)
1995-96	
Model 35 (8) .....	3.5 Pts. (1.6L)
8-1/4" (8) .....	4.4 Pts. (2.1L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.
- (3) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (4) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (5) - Includes Filter.
- (6) - Fill to bottom edge of filler plug hole.
- (7) - Add 5 ozs. of gear lubricant through indicator switch hole.
- (8) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.

## 82,500 MILE (132,000 KM) SERVICE

### 82,500 MILE (132,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Inspect Brake System
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter
	O2 Sensor (1989)
	Flush and Fill Engine Coolant, if not done in last 24 months
Lubrication Specifications	

Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6)(7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6)(8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)
(1) - DO NOT use Dexron-II ATF, Clutch chatter can result. (2) - SAE 10W-30 SH/CD is preferred. (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube. (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid. (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube. NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube. (6) - Use low pressure grease gun to prevent seal damage. (7) - Fill until lubricant squeezes out from the base of seals. (8) - Fill ball joint until seal starts to swell.	
Fluid Capacities	
Application	(1) Quantity
Cooling System	
2.5L (2)	10.0 Qts. (9.5L)
4.0L (3)	12.0 Qts. (11.4L)
Engine Oil (4)	
2.5L	4.0 Qts. (3.8L)
4.0L	6.0 Qts. (5.7L)
(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level. (2) - Includes 2.3 qts. (2.2L) for coolant recovery bottle. (3) - Includes 1.0 qt. (0.9L) for coolant recovery bottle. (4) - Includes Filter.	

## 90,000 MILE (144,000 KM) SERVICE

90,000 MILE (144,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Clean Battery and Battery Terminals
	Check/Adjust Accessory Drive Belt Tension
	Check Exhaust System & Heat Shielding
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Lube Parking Brake Ratio Lever Pivot
	Lube Manual Gearshift Control (4WD Transfer Case)
	Inspect Front Brake Pads & Rotors
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern

	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
Replace	
	Engine Oil
	Oil Filter
	Air Filter Element
	Spark Plugs
	Automatic Transmission Fluid, Filter and Adjust Bands
	PCV Valve (1) (2)
	Drive Belt (V-Type) (2) (3)
(1) - Replacement is recommended by Chrysler at this time, but it is not required to maintain the warranty on the PCV valve. (2) - Not required, if belt or PCV Valve was previously replaced (3) - Check and replace as needed.	
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-II E/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-II E ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Automatic Transmission (2)	
30RH (3-Speed)	
Fluid Change .....	4.0 Qts. (3.8L)
Overhaul (Dry Fill) .....	8.75 Qts. (8.2L)
AW4 (4-Speed)	
Fluid Change .....	2.0 Qts. (1.7L)
Overhaul (Dry Fill) .....	8.5 Qts. (8.0L)
Cooling System	
2.5L (3) .....	10.0 Qts. (9.5L)
4.0L (4) .....	12.0 Qts. (11.4L)
Engine Oil (5)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
Manual Transmission (6)	
AX4 (4-Speed AISIN) .....	7.4 Pts. (3.5L)
T4 (Borg-Warner) .....	3.9 Pts. (1.8L)
AX5 (5-Speed AISIN)	
2.5L (2WD) .....	7.0 Pts. (3.5L)
2.5L (4X4) .....	6.6 Pts. (3.2L)
T5 (Borg-Warner) .....	4.5 Pts. (2.1L)
AX15 (5-Speed AISIN)	
4.0L (2WD) .....	6.4 Pts. (3.1L)
4.0L (4X4) .....	6.5 Pts. (3.15L)
Transfer Case	
Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)
Drive Axles (6)	
Front Axle (Model 30)	
Command-Trac (Disconnect) .....	3.76 Pts. (1.65L)
(Disconnect Housing) (7) .....	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect) .....	3.13 Pts. (1.5L)
Rear Axle	
1989-94 (8) .....	2.5 Pts. (1.2L)
1995-96	
Model 35 (8) .....	3.5 Pts. (1.6L)
8-1/4" (8) .....	4.4 Pts. (2.1L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.
- (3) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (4) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (5) - Includes Filter.

- (6) - Fill to bottom edge of filler plug hole.
- (7) - Add 5 ozs. of gear lubricant through indicator switch hole.
- (8) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.

#### Service Labor Times

Application	(1) Hours
2.5L	
Automatic Transmission .....	4.2
Manual Transmission .....	2.4
4.0L	
Automatic Transmission .....	4.3
Manual Transmission .....	2.5
(1) - Add .6 hr. for vehicles equipped with 4WD.	

### 97,500 MILE (156,000 KM) SERVICE

#### 97,500 MILE (156,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Exhaust System & Heat Shielding
	Inspect Brake System
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Rotate Tires and Adjust Air Pressure (Including Spare)
Replace	
	Engine Oil
	Oil Filter
Lubrication Specifications	
Application	Specification
Automatic Transmission	

30RH (3-Speed) (1)	.....	Mopar 7176 ATF PLUS
AW4 (4-Speed)	.....	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	.....	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	.....	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)		
Temperatures Above 0°F (-18°C)	.....	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	.....	SAE 5W-30 API SH/CD ECII
Front Axle (3)	.....	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	.....	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	.....	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	.....	SAE 75W-140 Synthetic
Hydraulic Clutch	.....	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	.....	SAE 75W-90 API GL-5
Manual Steering Box	.....	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	.....	Power Steering Fluid
Transfer Case	.....	Dexron-IIIE ATF
Parking Brake Cable Guides	.....	NLGI Grade 2, GC-LB
Brake Caliper Bushings	.....	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	.....	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	.....	Light Engine Oil
Wheel Bearings	.....	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	.....	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	.....	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	.....	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	.....	Silicone Spray Lubricant
Wheel Lug Nut Torque	.....	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
Cooling System	
2.5L (2)	10.0 Qts. (9.5L)
4.0L (3)	12.0 Qts. (11.4L)
Engine Oil (4)	
2.5L	4.0 Qts. (3.8L)
4.0L	6.0 Qts. (5.7L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (3) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (4) - Includes Filter.

## 105,000 MILE (168,000 KM) SERVICE



105,000 MILE (168,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Fuel Lines, Connections
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Exhaust System & Heat Shielding
	Clean Battery and Battery Terminals
	Inspect Brake System
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Check/Lube Manual Steering Gear
	Lubricate Weatherstripping with Silicone
	Lubricate Door Hinges
	Lubricate Door Locks
	Check Body Drain Holes
	Rotate Tires and Adjust Air Pressure
Replace	
	Engine Oil
	Oil Filter
	Flush and Fill Engine Coolant, if not done in last 24 months

## Lubrication Specifications

Application	Specification
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Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6)(7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6)(8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)

- (1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

## Fluid Capacities

Application	(1) Quantity
-------------	--------------

Cooling System	
2.5L (2)	10.0 Qts. (9.5L)
4.0L (3)	12.0 Qts. (11.4L)
Engine Oil (4)	
2.5L	4.0 Qts. (3.8L)
4.0L	6.0 Qts. (5.7L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (3) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.

(4) - Includes Filter.

## 112,500 MILE (180,000 KM) SERVICE

### 112,500 MILE (180,000 KM) SERVICE

Service Or Inspect	
	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Clean Battery and Battery Terminals
	Check Exhaust System & Heat Shielding
	Check Operation of Horn, Wipers/Washers & All Exterior Lights
	Inspect Condition of Wiper Blades
	Check Headlight Alignment
	Check Seat Belt Webbing and Release Mechanisms
	Check Parking Brake Operation
	Check Shift/Clutch Interlock Operation
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Lube Parking Brake Ratio Lever Pivot
	Lube Manual Gearshift Control (4WD Transfer Case)
	Check/Lube Manual Steering Gear
	Inspect Front Brake Pads & Rotors
	Inspect Rear Brake Linings & Drums
	Inspect Brake System Hoses & Lines
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Lubricate Weatherstripping with Silicone

Lubricate Door Hinges	
Lubricate Door Locks	
Check Body Drain Holes	
Rotate Tires and Adjust Air Pressure	
Replace	
Engine Oil	
Oil Filter	
Manual Transmission Fluid	
Flush and Fill Engine Coolant, if not done in last 24 months	
Lubrication Specifications	
Application	Specification
Automatic Transmission	
30RH (3-Speed) (1)	Mopar 7176 ATF PLUS
AW4 (4-Speed)	Dexron-IIIE/Mercon ATF
Brake Master Cylinder	DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperatures Above 0°F (-18°C)	SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C)	SAE 5W-30 API SH/CD ECII
Front Axle (3)	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4)	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5)	SAE 75W-140 Synthetic
Hydraulic Clutch	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission	SAE 75W-90 API GL-5
Manual Steering Box	Multi-Purpose NLGI Grade 2EP
Power Steering Pump	Power Steering Fluid
Transfer Case	Dexron-IIIE ATF
Parking Brake Cable Guides	NLGI Grade 2, GC-LB
Brake Caliper Bushings	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins	GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges	Light Engine Oil
Wheel Bearings	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7)	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8)	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip	Silicone Spray Lubricant
Wheel Lug Nut Torque	80-110 ft. lbs. (115-145 N.m)
(1) - DO NOT use Dexron-II ATF, Clutch chatter can result.	
(2) - SAE 10W-30 SH/CD is preferred.	
(3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.	
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.	
(5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.	
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.	
(6) - Use low pressure grease gun to prevent seal damage.	

- (7) - Fill until lubricant squeezes out from the base of seals.  
 (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application (1) Quantity

#### Automatic Transmission (2)

##### 30RH (3-Speed)

Fluid Change ..... 4.0 Qts. (3.8L)  
 Overhaul (Dry Fill) ..... 8.75 Qts. (8.2L)

##### AW4 (4-Speed)

Fluid Change ..... 2.0 Qts. (1.7L)  
 Overhaul (Dry Fill) ..... 8.5 Qts. (8.0L)

#### Cooling System

2.5L (3) ..... 10.0 Qts. (9.5L)  
 4.0L (4) ..... 12.0 Qts. (11.4L)

#### Engine Oil (5)

2.5L ..... 4.0 Qts. (3.8L)  
 4.0L ..... 6.0 Qts. (5.7L)

#### Manual Transmission (6)

AX4 (4-Speed AISIN) ..... 7.4 Pts. (3.5L)  
 T4 (Borg-Warner) ..... 3.9 Pts. (1.8L)

##### AX5 (5-Speed AISIN)

2.5L (2WD) ..... 7.0 Pts. (3.5L)  
 2.5L (4X4) ..... 6.6 Pts. (3.2L)

T5 (Borg-Warner) ..... 4.5 Pts. (2.1L)

##### AX15 (5-Speed AISIN)

4.0L (2WD) ..... 6.4 Pts. (3.1L)  
 4.0L (4X4) ..... 6.5 Pts. (3.15L)

#### Transfer Case

Command-Trac (NV 231) ..... 2.2 Pts. (1.0L)  
 Selec-Trac (NV 242) ..... 3.0 Pts. (1.4L)

#### Drive Axles (6)

##### Front Axle (Model 30)

Command-Trac (Disconnect) ..... 3.76 Pts. (1.65L)  
 (Disconnect Housing) (7) ..... 5.0 Ozs. (0.15L)  
 Selec-Trac (Non-Disconnect) ..... 3.13 Pts. (1.5L)

##### Rear Axle

1989-94 (8) ..... 2.5 Pts. (1.2L)  
 1995-96  
 Model 35 (8) ..... 3.5 Pts. (1.6L)  
 8-1/4" (8) ..... 4.4 Pts. (2.1L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.  
 (2) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.  
 (3) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.  
 (4) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.  
 (5) - Includes Filter.  
 (6) - Fill to bottom edge of filler plug hole.  
 (7) - Add 5 ozs. of gear lubricant through indicator switch hole.  
 (8) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.

## 120,000 MILE (192,000 KM) SERVICE

120,000 MILE (192,000 KM) SERVICE

Service Or Inspect

	Verify Last Major Service Was Performed
	Check Fluid Levels
	Check Cooling System Hoses and Clamps
	Check Coolant Strength
	Check Exhaust System & Heat Shielding
	Clean/Inspect Battery and Battery Terminals
	Check/Adjust Accessory Drive Belts
	Ignition Timing
	Clean EGR Passages (if equipped)
	Check/Lube Manual Steering Gear
	Inspect Underside of Vehicle (Bolts & Threaded Fasteners)
	Inspect C/V Joint boots (4WD)
	Check Drive Shaft Seals
	Lubricate Ball Joints, Steering Linkage & Suspension
	Lube Drive Shaft U-Joints and Slip Splines
	Lube Front Axle Drive Joint and Pivot Bearings (4WD)
	Suspension Bushings, Springs, Arms & Rear Jounce Bumpers
	Parking Brake System
	Inspect Shocks for Leakage
	Inspect Tire Wear Pattern
	Rotate Tires and Adjust Air Pressure (Including Spare)
	Replace
	Engine Oil
	Oil Filter
	Spark Plugs
	Ignition Cables
	Distributor Cap and Rotor
	Air Filter Element
	Fuel Filter (In-Line)
	PCV Valve (1)
	PCV Filter

EGR Valve & Tube (1989-92)
Emission System Vacuum Hoses
Vacuum Operated Emission Components (1989-92)
Drive Belt (V-Type) (2)
Flush and Fill Engine Coolant, if not done in last 24 months
Automatic Transmission Fluid, Filter and Adjust Bands
Transfer Case Fluid
Front & Rear Axle Fluid
(1) - Replacement is recommended by Chrysler at this time, but it is not required to maintain the warranty on the PCV valve. (2) - Check and replace as needed.
Lubrication Specifications
Application
Specification
Automatic Transmission
30RH (3-Speed) (1) ..... Mopar 7176 ATF PLUS
AW4 (4-Speed) ..... Dexron-IIIE/Mercon ATF
Brake Master Cylinder ..... DOT 3 (SAE J-1703F) Brake Fluid
Engine Coolant ..... 50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)
Temperatures Above 0°F (-18°C) ..... SAE 10W-30 API SH/CD ECII
Temperatures Below 32°F (0°C) ..... SAE 5W-30 API SH/CD ECII
Front Axle (3) ..... SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle ..... SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4) ..... SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5) ..... SAE 75W-140 Synthetic
Hydraulic Clutch ..... DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission ..... SAE 75W-90 API GL-5
Manual Steering Box ..... Multi-Purpose NLGI Grade 2EP
Power Steering Pump ..... Power Steering Fluid
Transfer Case ..... Dexron-IIIE ATF
Parking Brake Cable Guides ..... NLGI Grade 2, GC-LB
Brake Caliper Bushings ..... GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins ..... GE 661 or DOW 111 Silicone Grease
Door & Hood Hinges ..... Light Engine Oil
Wheel Bearings ..... Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints ..... Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7) .... Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8) ..... Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip ..... Silicone Spray Lubricant
Wheel Lug Nut Torque ..... 80-110 ft. lbs. (115-145 N.m)
(1) - DO NOT use Dexron-II ATF, Clutch chatter can result.
(2) - SAE 10W-30 SH/CD is preferred.
(3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
(4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
(5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.
NOTE: Before using SAE 75W-140 Synthetic, old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.

- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

#### Fluid Capacities

Application	(1) Quantity
-------------	--------------

##### Automatic Transmission (2)

###### 30RH (3-Speed)

Fluid Change .....	4.0 Qts. (3.8L)
Overhaul (Dry Fill) .....	8.75 Qts. (8.2L)

###### AW4 (4-Speed)

Fluid Change .....	2.0 Qts. (1.7L)
Overhaul (Dry Fill) .....	8.5 Qts. (8.0L)

##### Cooling System

2.5L (3) .....	10.0 Qts. (9.5L)
4.0L (4) .....	12.0 Qts. (11.4L)

##### Engine Oil (5)

2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)

##### Manual Transmission (6)

AX4 (4-Speed AISIN) .....	7.4 Pts. (3.5L)
T4 (Borg-Warner) .....	3.9 Pts. (1.8L)

###### AX5 (5-Speed AISIN)

2.5L (2WD) .....	7.0 Pts. (3.5L)
2.5L (4X4) .....	6.6 Pts. (3.2L)

T5 (Borg-Warner) .....	4.5 Pts. (2.1L)
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###### AX15 (5-Speed AISIN)

4.0L (2WD) .....	6.4 Pts. (3.1L)
4.0L (4X4) .....	6.5 Pts. (3.15L)

##### Transfer Case

Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)

##### Drive Axles (6)

###### Front Axle (Model 30)

Command-Trac (Disconnect) .....	3.76 Pts. (1.65L)
(Disconnect Housing) (7) .....	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect) .....	3.13 Pts. (1.5L)

###### Rear Axle

1989-94 (8) .....	2.5 Pts. (1.2L)
1995-96	

Model 35 (8) .....	3.5 Pts. (1.6L)
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8-1/4" (8) .....	4.4 Pts. (2.1L)
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- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.
- (3) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (4) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (5) - Includes Filter.
- (6) - Fill to bottom edge of filler plug hole.
- (7) - Add 5 ozs. of gear lubricant through indicator switch hole.
- (8) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip differential lubricant additive first, then add new fluid.

#### Service Labor Times

Application	(1) Hours
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1989-92

2.5L



Automatic Transmission .....	9.3
Manual Transmission .....	7.5
4.0L	
Automatic Transmission .....	10.1
Manual Transmission .....	8.3
1993-96	
2.5L	
Automatic Transmission .....	7.6
Manual Transmission .....	5.8
4.0L	
Automatic Transmission .....	7.8
Manual Transmission .....	6.0
(1) - Add .6 hour for vehicles equipped with 4WD.	

## LUBRICATION SPECIFICATIONS

### LUBRICATION SPECIFICATIONS TABLE

Application	Specification
Automatic Transmission	
30RH (3-Speed) (1) .....	Mopar 7176 ATF PLUS
AW4 (4-Speed) .....	Dexron-III/Mercon ATF
Brake Master Cylinder .....	DOT 3 (SAE J-1703F) Brake Fluid
Coolant .....	50/50 Ethylene-Glycol & Water Mix
Engine Oil (2)	
Temperature Range	
Above 0° F (-18°C) .....	SAE 10W-30 API SH/CD ECII
Less Than 60° F (16°C) .....	SAE 5W-30 API SH/CD ECII
Front Axle (3) .....	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle .....	SAE 80W-90 API GL-5 (MIL-L-2105C)
Rear Axle (Trac-Lok) (4) .....	SAE 80W-140 API GL-5
Rear Axle (Trailer Towing) (5) .....	SAE 75W-140 Synthetic
Hydraulic Clutch .....	DOT 3 (SAE J-1703F) Brake Fluid
Manual Transmission .....	SAE 75W-90 API GL-5
Manual Steering Box .....	Multi-Purpose NLGI Grade 2EP
Power Steering Pump .....	Power Steering Fluid
Transfer Case .....	Dexron-IIIE ATF
Brake Caliper Bushings .....	GE 661 or DOW 111 Silicone Grease
Caliper Slide Pins .....	GE 661 or DOW 111 Silicone Grease
Wheel Bearings .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Drive Shaft U-Joints .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Steering Linkage (6) (7) ...	Multi-Purpose NLGI Grade 2EP, GC-LB
Ball Joints (6) (8) .....	Multi-Purpose NLGI Grade 2EP, GC-LB
Weatherstrip .....	Silicone Spray Lubricant

- (1) - DO NOT use Dexron-III ATF, Clutch chatter can result.
- (2) - SAE 10W-30 SH/CD is preferred.
- (3) - DO NOT use heavier weight lubricant, as it will cause axle engagement difficulties, use only SAE 80W-90 lube.
- (4) - Add 4 ozs. (118 ml) of Limited-Slip differential lubricant additive when changing fluid.
- (5) - For vehicles operating under heavy-duty towing conditions, use SAE 75W-140 Synthetic lube.  
NOTE: Before using SAE 75W-140 Synthetic the old fluid must be DRAINED and FLUSHED with clean mineral based (non-synthetic) axle lubricant. Then refill with new synthetic lube.
- (6) - Use low pressure grease gun to prevent seal damage.
- (7) - Fill until lubricant squeezes out from the base of seals.
- (8) - Fill ball joint until seal starts to swell.

## FLUID CAPACITIES

FLUID CAPACITIES TABLE

Application	Quantity (1)
A/C System R-12 Refrigerant Capacity	
1989-90 .....	36-40 Ozs.
1991-93	
Cherokee 2-Door .....	32 Ozs.
Cherokee 4-Door .....	38 Ozs.
A/C System R-134a Refrigerant Capacity (2)	
1994-96 .....	32 Ozs.
Automatic Transmission (3)	
30RH (3-Speed)	
Fluid Change .....	4.0 Qts. (3.8L)
Overhaul (Dry Fill) .....	8.75 Qts. (8.2L)
AW4 (4-Speed)	
Fluid Change .....	2.0 Qts. (1.7L)
Overhaul (Dry Fill) .....	8.5 Qts. (8.0L)
Cooling System	
2.5L (4) .....	10.0 Qts. (9.5L)
4.0L (5) .....	12.0 Qts. (11.4L)
Engine Oil (6)	
2.5L .....	4.0 Qts. (3.8L)
4.0L .....	6.0 Qts. (5.7L)
Fuel Tank .....	20.2 Gals. (76.4L)
Manual Transmission (7)	
AX4 (4-Speed AISIN) .....	7.4 Pts. (3.5L)
T4 (4-Speed Borg-Warner) .....	3.9 Pts. (1.8L)
AX5 (5-Speed AISIN)	
2.5L (2WD) .....	7.0 Pts. (3.5L)
2.5L (4X4) .....	6.6 Pts. (3.2L)
T5 (5-Speed Borg-Warner) .....	4.5 Pts. (2.1L)
AX15 (5-Speed AISIN)	
4.0L (2WD) .....	6.4 Pts. (3.1L)
4.0L (4X4) .....	6.5 Pts. (3.15L)
Transfer Case	
Command-Trac (NV 231) .....	2.2 Pts. (1.0L)
Selec-Trac (NV 242) .....	3.0 Pts. (1.4L)
Drive Axles (7)	
Front Axle (Model 30)	
Command-Trac (Disconnect) .....	3.76 Pts. (1.65L)
(Disconnect Housing) (8) .....	5.0 Ozs. (0.15L)
Selec-Trac (Non-Disconnect) .....	3.13 Pts. (1.5L)
Rear Axle	
1989-94 (9) .....	2.5 Pts. (1.2L)
1995-96	
Model 35 (9) .....	3.5 Pts. (1.6L)
8-1/4" (9) .....	4.4 Pts. (2.1L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
- (2) - Use of R-12 in a R-134a system will result in SEVERE DAMAGE
- (3) - Total quantity required will vary, after adding amount shown check dipstick and fill to proper level.
- (4) - Includes 2.3 qts. (2.2L) for coolant recovery bottle.
- (5) - Includes 1.0 qt. (0.9L) for coolant recovery bottle.
- (6) - Includes Filter.
- (7) - Fill to bottom edge of filler plug hole.

- (8) - Add 5 ozs. of gear lubricant through indicator switch hole.
  - (9) - If equipped with TRAC-LOK, add 4 ozs. of Limited-Slip  
differential lubricant additive first, then add new fluid.
-

# 97I002000: SHIFT INTERLOCK

1993 Jeep Cherokee

## NHTSA RECALL BULLETIN

Model(s): 1984-95 Jeep Cherokee  
1993-95 Jeep Grand Cherokee  
Campaign No: 97I002000  
Number of Affected Vehicles: 2200000  
Beginning Date of Manufacture: 1983 AUG  
Ending Date of Manufacture: 1995 JUL

## VEHICLE DESCRIPTION:

Multipurpose passenger vehicles equipped with automatic transmissions.

## DESCRIPTION OF DEFECT:

This is not a safety recall in accordance with Federal Regulation 573. However, it is deemed a safety improvement campaign by the agency.

Drivers can mistakenly step on the accelerator pedal when they intend to step on the brake pedal.

## CONSEQUENCE OF DEFECT:

Pedal misapplication by a driver can cause unintended acceleration.

## CORRECTIVE ACTION

Dealers will install a shift interlock on the automatic transmission of these vehicles.

Chrysler has decided to conduct a safety improvement campaign to install a shift interlock on these vehicles. Owners can contact Chrysler at 1-800-853-1403.

## ADDITIONAL INFORMATION:

The National Highway Traffic Safety Administration operates Monday through Friday from 8:00 AM to 4:00 PM, Eastern Time. For more information call (800) 424-9393 or (202) 366-0123. For the hearing impaired, call (800) 424-9153.

# STARTER - BOSCH/MITSUBISHI

1993 Jeep Cherokee

1993 ELECTRICAL  
Chrysler Corp. Starters - Bosch & Mitsubishi

Jeep; Cherokee, Grand Cherokee, Wrangler

## DESCRIPTION

Both Bosch and Mitsubishi starters are permanent-magnet type. A planetary gear train transmits power between starter motor and pinion shaft. Both starters are 12-volt units with solenoid mounted on starter housing.

## TROUBLE SHOOTING

### STARTER MOTOR NOISE

STARTER TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Very high frequency whine before engine starts; engine starts ok	Excessive distance between pinion gear and flywheel/drive plate gear.	Shim starter motor toward flywheel/drive plate.
Very high frequency whine after engine starts with ignition key released, engine starts okay.	Insufficient distance between starter motor pinion gear & flywheel/drive plate runout can cause noise to be intermittent.	Shim starter away from flywheel/drive plate. Check flywheel drive plate for bent, unusual wear, and excess runout. Replace flywheel/drive plate as needed.
A loud "whoop" after engine starts while starter motor is engaged.	Most probably cause is defective overrun clutch. Overrun clutch replacement normally corrects this condition.	Replace overrun clutch or drive assembly.
A "Rumble," "Growl," or "Knock" as starter motor coasts to stop after engine starts.	Most probably cause is, bent or unbalanced starter motor armature. Armature replacement normally corrects this condition.	Replace starter motor armature.

## TESTING (ON-VEHICLE)

### COLD CRANKING TEST

NOTE: Ensure battery is fully charged. A cold engine increases starter draw amperage.

- 1) Connect battery load/charging system tester to battery,

and connect remote starter switch to starter relay. Set voltmeter selector to 18-volt position. Adjust ammeter reading to zero.

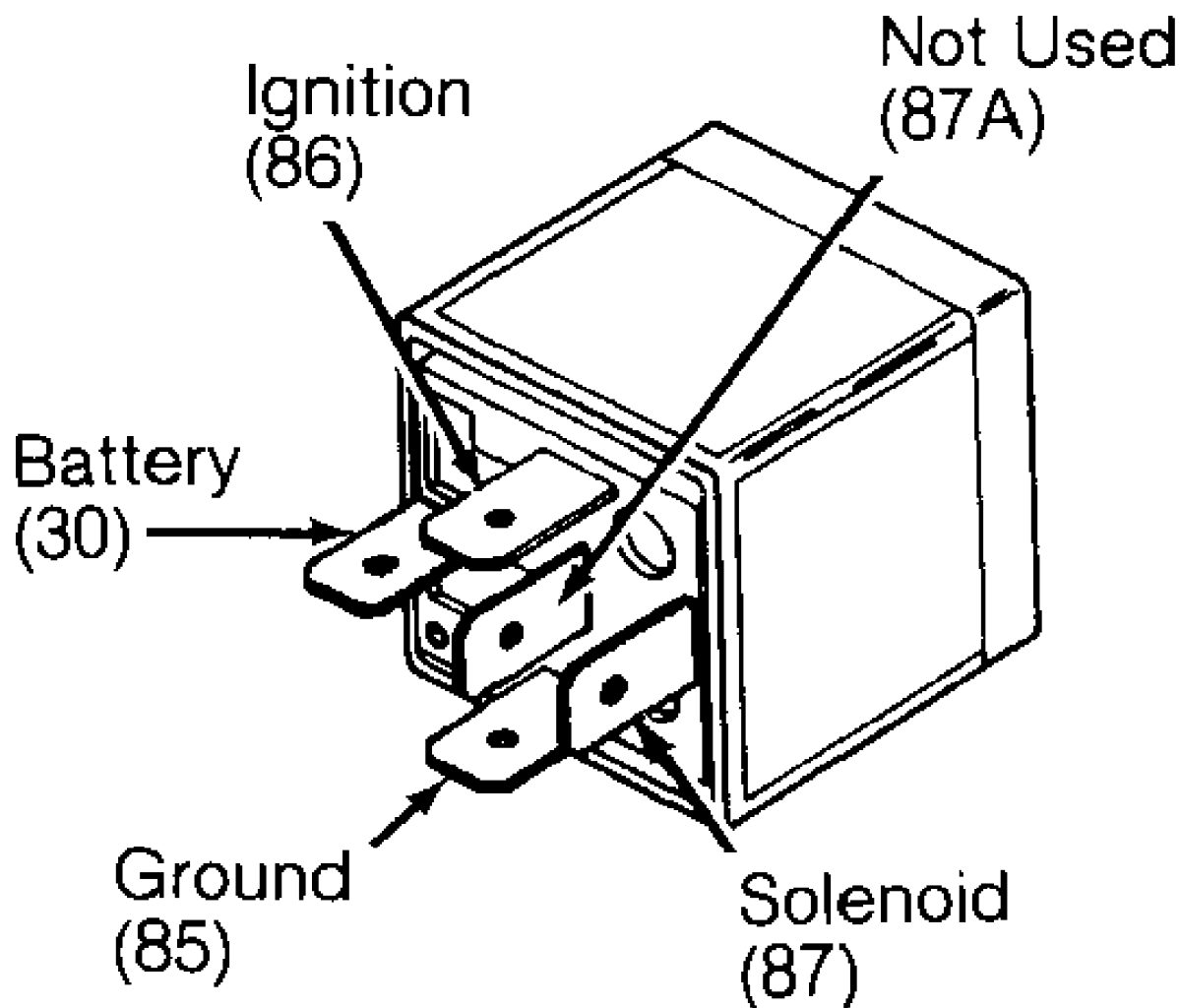
2) Disconnect coil wire from distributor cap. Attach coil wire to ground to prevent engine from starting. Crank engine, and note cranking voltage and amperage. Replace or repair starter if it is not to specifications. See appropriate STARTER SPECIFICATIONS.

### STARTER RELAY TEST

1) Remove starter relay from Power Distribution Center (PDC). Using an ohmmeter, check for continuity between terminals No. 30 and 87A. If no continuity exists, replace relay. See Fig. 1.

2) Check resistance between terminals No. 85 and 86. If resistance is not 70-80 ohms, replace starter relay.

3) Connect battery to terminals No. 85 and 86. Check for continuity between terminals No. 30 and 87. If no continuity exists, replace starter relay.



93C76101

Fig. 1: Identifying Starter Relay Terminals  
Courtesy of Chrysler Corp.

### SOLENOID TEST

#### Continuity Test

1) Disconnect wire from solenoid field coil terminal (large terminal connected to starter body). Using an ohmmeter, test for continuity between field terminal and solenoid terminal (small terminal). Continuity should exist.

2) Test for continuity between solenoid terminal and solenoid housing. Continuity should exist. If continuity does not exist in either test, solenoid has open circuit. Replace solenoid.

#### Functional Test

1) With a fully-charged battery, connect a heavy gauge jumper wire between battery terminal and solenoid terminal wire connector at starter relay. If engine cranks, solenoid is okay.

2) If engine does not crank, check battery cable for voltage to starter solenoid BAT terminal. Jump starter relay terminals as in step 1), checking for voltage at solenoid terminal No. 50. Repair as necessary. If engine still does not crank, repair or replace starter.

## BENCH TESTING

### ARMATURE TEST

#### Short Circuit

Place armature in a growler. While rotating armature slowly, hold growler's blade parallel to and touching armature core. Blade vibrates if armature is shorted. Replace shorted armature.

#### Ground

Using growler or a self-powered test light, touch one lead to armature shaft and other lead to each commutator bar. See Fig. 2. If light glows at any point during procedure, armature is grounded. Replace grounded armature.

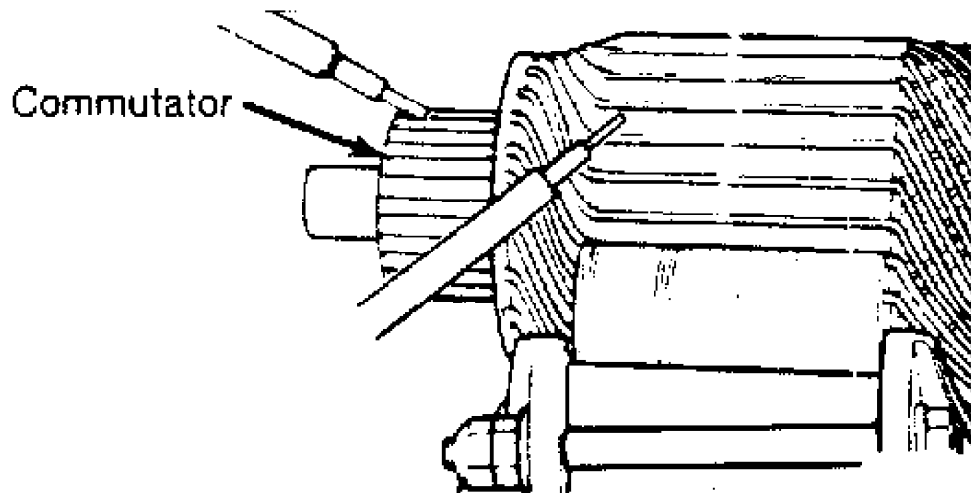


Fig. 2: Testing Starter Armature For Ground  
Courtesy of Chrysler Corp.

### DRIVE CLUTCH CHECK

While holding drive clutch housing, rotate pinion. Drive pinion should rotate smoothly in only one direction (pinion should engage and lock in opposite direction). If drive unit does not operate properly or if pinion is worn or burred, replace drive clutch.

## REMOVAL & INSTALLATION

### STARTER

#### Removal & Installation (2.5L)

1) Disconnect negative battery cable. Remove exhaust pipe clamp from bracket. See Fig. 3. On Cherokee with automatic transmission, remove nut and bolt from forward end of brace rod. Remove brace rod and bracket.

2) On vehicles with manual transmission, remove nut, bolt and bracket from bellhousing. On all models, disconnect battery cable and solenoid feed wire from starter solenoid. To install, reverse removal procedure.

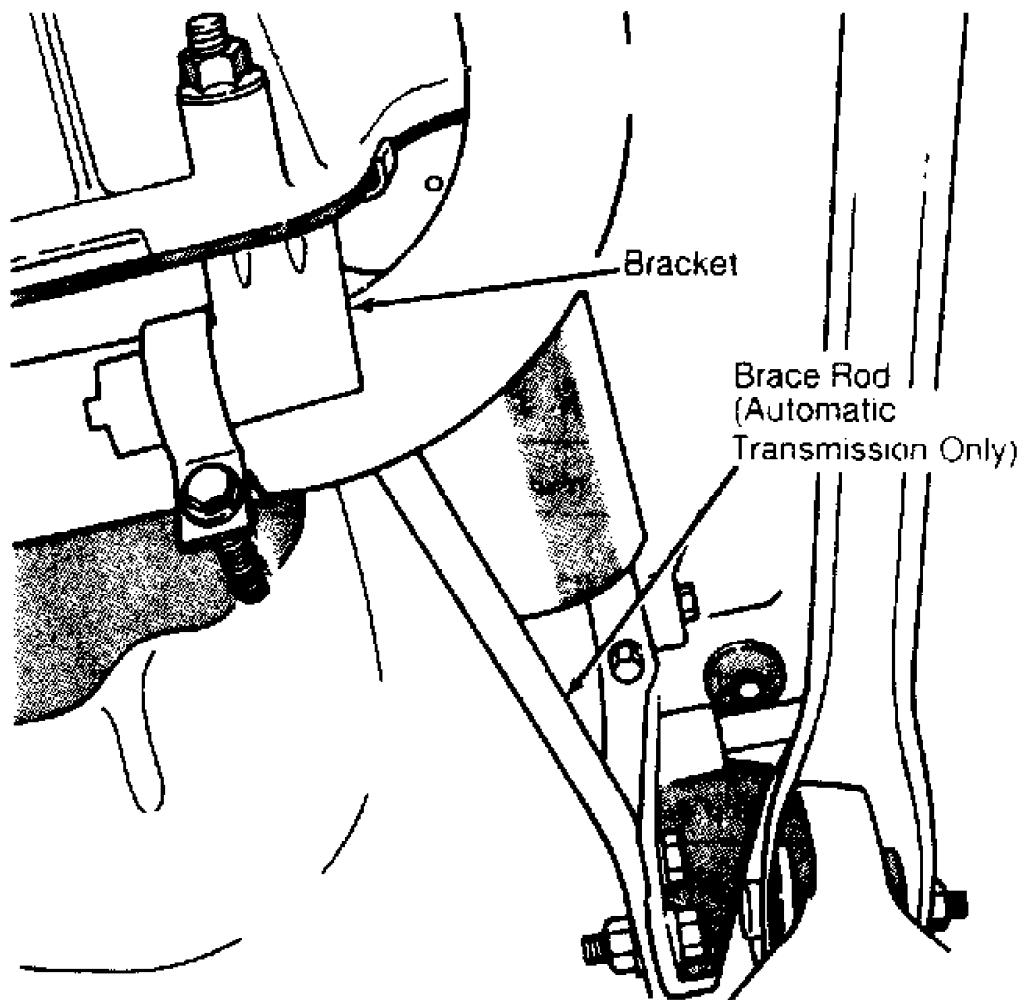


Fig. 3: Removing Engine Exhaust Clamp & Brace (2.5L)  
Courtesy of Chrysler Corp.

#### Removal & Installation (4.0L)

Disconnect negative battery cable. Raise and support vehicle.



Disconnect starter battery cable and solenoid feed wire. Remove starter from flywheel housing. To install, reverse removal procedure.

# OVERHAUL

NOTE: For exploded views of starters, see Figs. 4 and 5.

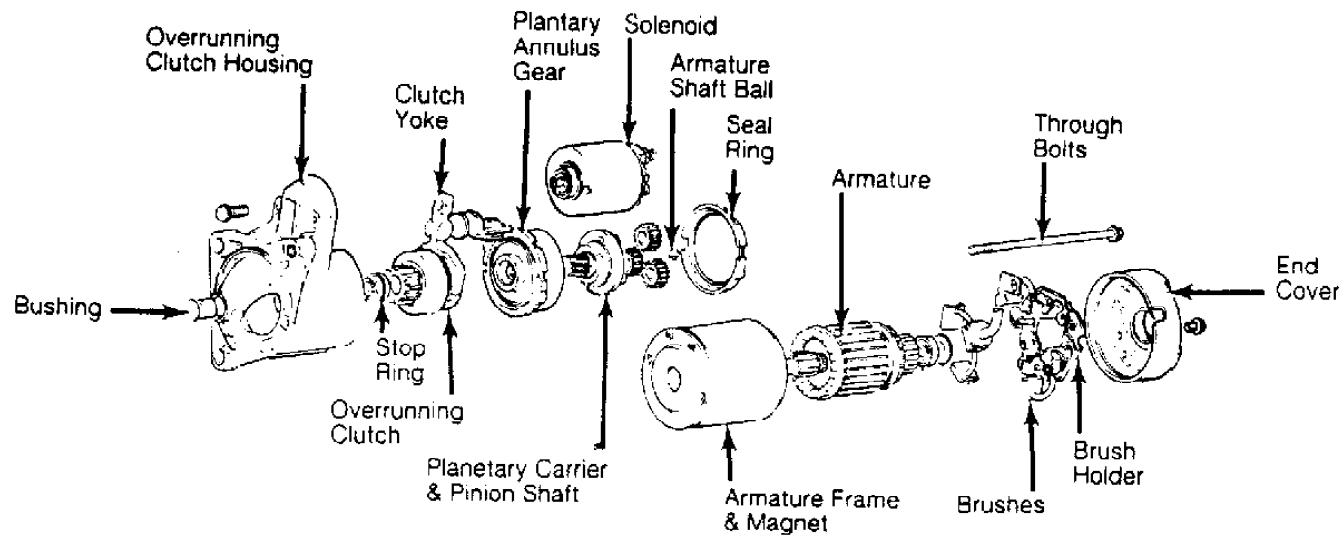


Fig. 4: Exploded View Of Mitsubishi Starter (4.0L)  
 Courtesy of Chrysler Corp.

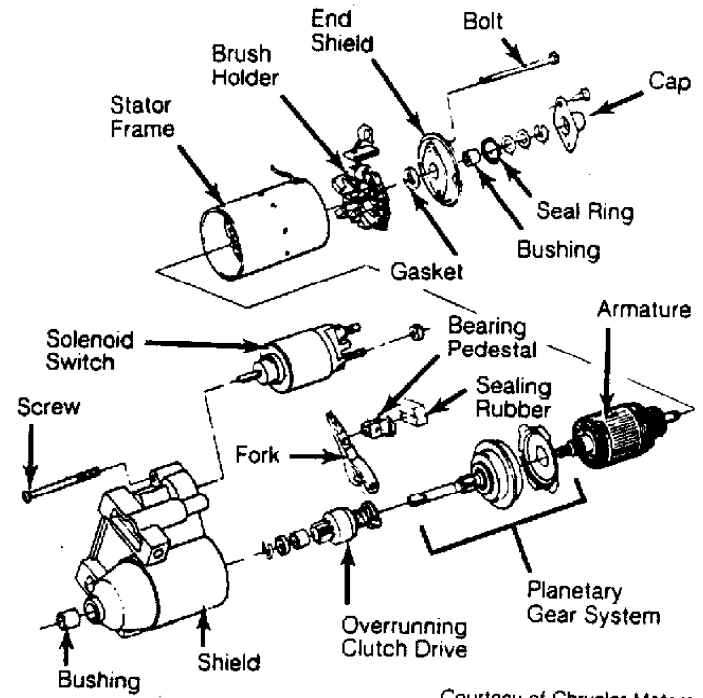


Fig. 5: Exploded View Of Bosch Starter (2.5L)  
 Courtesy of Chrysler Corp.

# STARTER SPECIFICATIONS

## BOSCH

BOSCH STARTER SPECIFICATIONS TABLE

Application	Specification
Carbon Brush Minimum Length .....	.314" (8.0 mm)
Commutator	
Diameter .....	1.23-1.27" (31.2-32.3 mm)
Runout .....	.0004" (.01 mm)
Armature	
Core Runout .....	.002" (.05 mm)
End Play .....	.002" (.05 mm)
Cranking Test	
Test Voltage .....	12.5 Volts
Minimum Voltage .....	9.6 Volts
Amps .....	160 Amps
No-Load Test @ 11.5 Volts	
Maximum Amps .....	75 Amps
Minimum RPM .....	2900 RPM
Solenoid Hold-In Test Winding Voltage .....	.2-2 Volts
Solenoid Pull-In Test Winding Voltage .....	6-7.3 Volts

## MITSUBISHI

MITSUBISHI STARTER SPECIFICATIONS TABLE

Application	Specification
Carbon Brush Minimum Length .....	.354" (9 mm)
Commutator	
Diameter .....	1.118-1.161" (28.4-29.5 mm)
Runout .....	.001" (.03 mm)
Armature	
Core Runout .....	.003" (.08 mm)
End Play .....	.023" (.58 mm)
Cranking Test	
Test Voltage .....	12.5 Volts
Minimum Voltage .....	9.6 Volts
Amps .....	130
No-Load Test @ 11.5 Volts	
Maximum Amps .....	80 Amps
Minimum RPM .....	2500 RPM
Solenoid Hold-In Test Winding Voltage ...	3.5 Volts (Min.)
Solenoid Pull-In Test Winding Voltage ...	7.8 Volts (Max.)

## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Starter-To-Block Bolts .....	33 (45)

# STEERING COLUMN

## 1993 Jeep Cherokee

1993 STEERING  
Chrysler Corp. Steering Columns

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION & OPERATION

All models use collapsible steering columns. All columns have integral ignition switch and locking device. Optional tilt wheel is available with both A/T and M/T models. Transmission shift linkage is integral on all models except those with floor shift. See Figs. 1 and 2.

Grand Cherokee and Grand Wagoneer models are equipped with driver-side air bag. Steering column on these models is serviced only as an assembly, except for steering wheel, switches and wiring.

**WARNING:** On models with Supplemental Restraint System (SRS), air bag system **MUST** be disabled before servicing ANY steering column component. Disabling system will prevent accidental air bag deployment, resulting in possible serious injury or property damage.

### AIR BAG DISABLING

BEFORE servicing ANY steering column or air bag component, disconnect and shield negative (ground) battery cable. Wait 2 MINUTES to allow air bag system capacitor to deplete its residual charge. Proceed with steering column service.

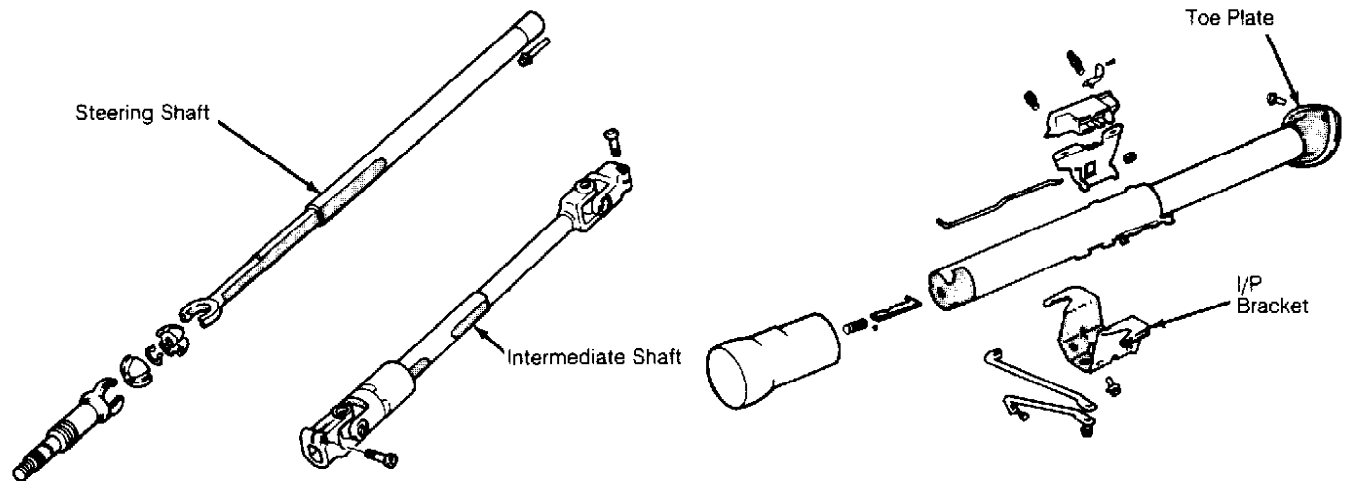


Fig. 1: Steering Column & Intermediate Shaft (Cherokee & Wrangler)  
Courtesy of Chrysler Corp.

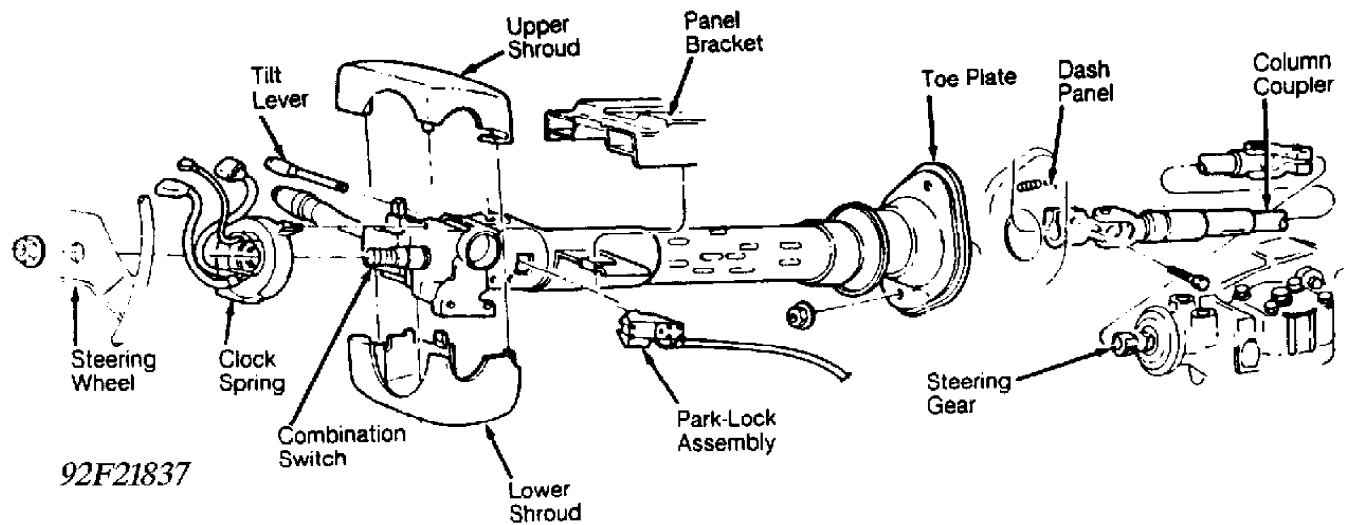


Fig. 2: Exploded View Of Steering Column (All Others)  
 Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

### STEERING WHEEL & HORN PAD R & I

#### Removal & Installation (Cherokee & Wrangler)

- 1) Disconnect negative battery cable. Place wheels in straight-ahead position. On models with standard steering wheel, remove horn button retaining screws from rear of steering wheel. Disconnect wiring from horn button and remove.
- 2) On models with sport steering wheel (round horn button), remove horn button by pulling button upward. If necessary, remove horn internal components. Place components in order of removal.
- 3) Remove steering wheel retaining nut. Reference mark steering wheel and steering shaft. Using puller, remove steering wheel. To install, reverse removal procedure. Align marks made during removal. Tighten steering wheel retaining nut to specification. See TORQUE SPECIFICATIONS.

#### Removal & Installation (Grand Cherokee & Grand Wagoneer)

- 1) Disable air bag system. See AIR BAG DISABLING. Ensure steering wheel is in straight-ahead position. Remove nuts mounting air bag module to steering wheel. Remove screws securing cruise control switch to steering wheel. Disconnect wiring connectors. Remove air bag module and cruise control switch assembly.
- 2) Pry trim covers from back of steering wheel and remove horn switch mounting screws. Disconnect horn wires. Remove horn switch.
- 3) Remove steering wheel retaining nut. Reference mark steering wheel and steering shaft. Using puller, remove steering wheel. To install, reverse removal procedure. Align marks made during removal. Tighten steering wheel retaining nut to specification.

### COMBINATION SWITCH R & I (GRAND CHEROKEE & GRAND WAGONEER)

#### Removal & Installation

- 1) Disable air bag system. See AIR BAG DISABLING. Remove tilt lever (if equipped). Remove upper and lower steering column covers. Remove steering panel trim panel and knee bolster. Remove steering column-to-mounting bracket retaining nuts. Lower steering column. See

Fig. 2.

2) Using Tamper Proof Torx Bit (TTXR20B2), remove combination switch retaining screws. Gently roll combination switch away from column. Unscrew connector retaining screw from combination switch. Screw will remain in connector. Disconnect connector. Remove switch. To install, reverse removal procedure.

## PARK-LOCK CABLE R & I

**NOTE:** Park-Lock (Shifter/Ignition Interlock on Grand Cherokee and Grand Wagoneer) cable mechanism is used on all models equipped with floor shift and AW-4 transmission (except Wrangler). Park-Lock system locks shifter in PARK position when key switch is in LOCK or ACCESSORY position.

### Removal & Installation

1) Disconnect negative battery cable. Remove lower instrument panel trim. Remove steering column attaching nuts and lower steering column. Disconnect park-lock cable from steering column and remove cable from bracket. See Fig. 2.

2) Remove center console. Remove moldings, panels, accelerator pedal bracket and carpet screws. Pull carpet back for access to gear selector lever bellcrank, disconnect park-lock cable and remove cable. To install, reverse removal procedure.

## COLUMN SHIFT TYPE STEERING COLUMN R & I

**NOTE:** Steering column removal is NOT needed for lock plate cover, lock plate, steering shaft retaining ring, canceling cam, turn signal switch, upper bearing preload spring, or ignition switch/lock cylinder removal.

### Removal

1) Disconnect negative battery cable. Remove steering wheel and horn pad. See STEERING WHEEL & HORN PAD R & I. Remove damper assembly (if equipped). Remove turn signal lever. Disconnect shift cable grommet by prying it from shift lever.

2) Paint alignment marks on intermediate shaft and steering shaft for installation reference. Disconnect steering shaft from intermediate shaft. If necessary, remove lower part of instrument panel, disconnect bracket from instrument panel and lower steering column.

3) Disconnect ignition switch, dimmer switch, turn signal switch, windshield wiper switch and cruise control electrical connectors. Disconnect park-lock cable (if equipped). Disconnect steering column toe plate from instrument panel, remove steering column from vehicle.

**CAUTION:** When removed from vehicle, steering column must be handled very carefully. The plastic fasteners that maintain the rigidity of the energy-absorbing components could be sheared or loosened.

**NOTE:** On vehicles equipped with cruise control and manual transmission, take care not to damage clutch pedal cruise control switch.

### Installation

1) Align lower shaft with lower coupling and insert shaft. Raise column assembly into position onto studs. Loosely install nuts and washers in break-away capsules. Pull column rearward. Tighten nuts to specification. See TORQUE SPECIFICATIONS.

2) Install NEW shift lever grommet using pliers and back-up

washer to snap grommet into place. Use a multipurpose grease to aid installation. Connect gearshift cable rod to shift lever by snapping rod into grommet with pliers.

3) Adjust linkage. Place steering wheel on shaft with master splines aligned. Place damper assembly inside steering wheel (if equipped). Install steering wheel retaining nut. Tighten to specification.

4) Install horn pad assembly. Connect electrical connectors at steering column jacket. Connect negative battery cable. Test operation of lights and horn.

5) On models with automatic transmission, install gearshift indicator pointer. Slowly move gearshift lever from Low to Park position, pausing briefly at each position. Readjust pointer as required. Install instrument panel steering column cover.

## **FLOOR SHIFT TYPE STEERING COLUMN R & I**

### **Removal & Installation**

Removal procedure is same as for column shift with following exceptions: in place of rotating shift bowl, a plastic shroud is fixed to lock housing. Shroud covers jacket and lock inhibitor assembly with a tab holding it in place. Replace shroud by removing key/lock housing from jacket.

## **OVERHAUL**

**NOTE:** Manufacturer does not recommend overhaul of steering column on Grand Cherokee and Grand Wagoneer. If service is required, replace steering column as an assembly. Steering wheel, switches and wiring can be serviced separately.

## **NON-TILT WHEEL COLUMN OVERHAUL**

**NOTE:** If repairs are performed while in vehicle, DO NOT allow shaft to slip out of column.

### **Disassembly**

1) If column is removed from vehicle, attach a column supporting fixture. See Fig. 3. If the column is in the vehicle, disconnect negative battery cable. Remove the steering wheel. Refer to STEERING WHEEL & HORN PAD R & I under REMOVAL & INSTALLATION. Remove lock plate cover.

**WARNING:** Lock plate is retained by a very strong spring force. DO NOT attempt to remove steering shaft snap ring without using appropriate lock plate depressor.

2) Depress lock plate, remove snap ring and discard. Remove lock plate, cancel cam, upper bearing preload spring and washer. Remove hazard warning switch knob, press knob inward then turn counterclockwise, remove from column.

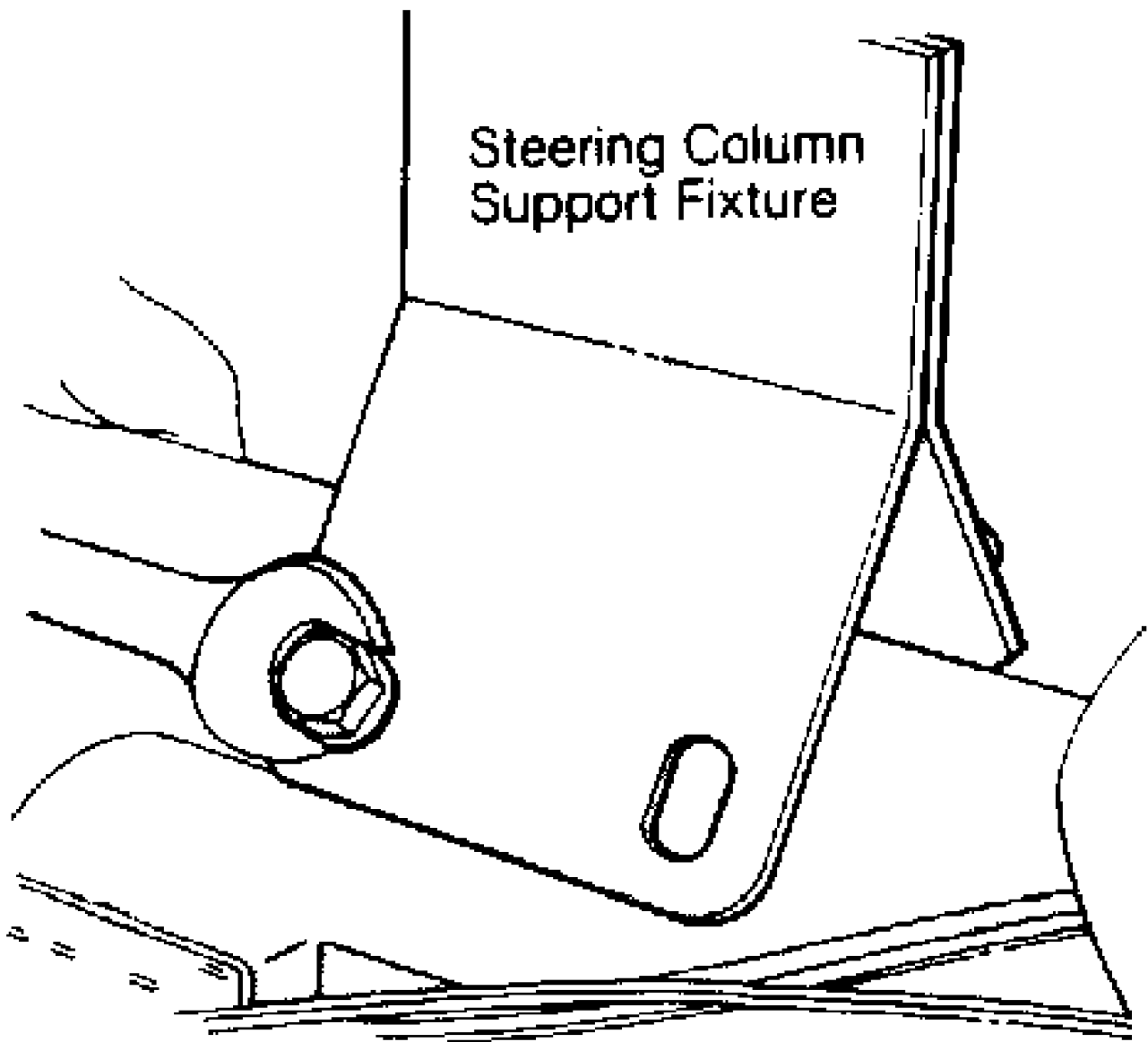


Fig. 3: Attaching Steering Column Support Fixture  
Courtesy of Chrysler Corp.

3) Remove turn signal/wiper/cruise control stalk by pulling straight out from column. Disconnect turn signal wiring harness at lower end of column.

4) Remove turn signal/dimmer retaining screws and remove switch. Guide harness and switch up and out of column. Remove all other wiring harnesses in steering column.

NOTE: Wrap tape around turn signal wire harness to prevent entanglement during removal.

5) Turn ignition switch to ON position. Remove key warning buzzer and contacts as a unit with needle nose pliers. Insert a small screwdriver into right hand slot adjacent to switch attaching screw boss. Depress spring latch located at bottom of slot and pull cylinder out of column.

6) On models equipped with floor shift, proceed to step 10).

On column shift models, remove gear selector lever upper pivot pin, selector lever and upper bearing thrust washer. Remove 4 screws attaching key/lock cylinder housing to steering column, remove key/lock cylinder housing.

7) Remove thrust cap and ignition switch actuating rod and rack. Remove rack preload spring, shaft lock bolt and spring from housing. Remove shift lever detent plate from housing. See Fig. 4.

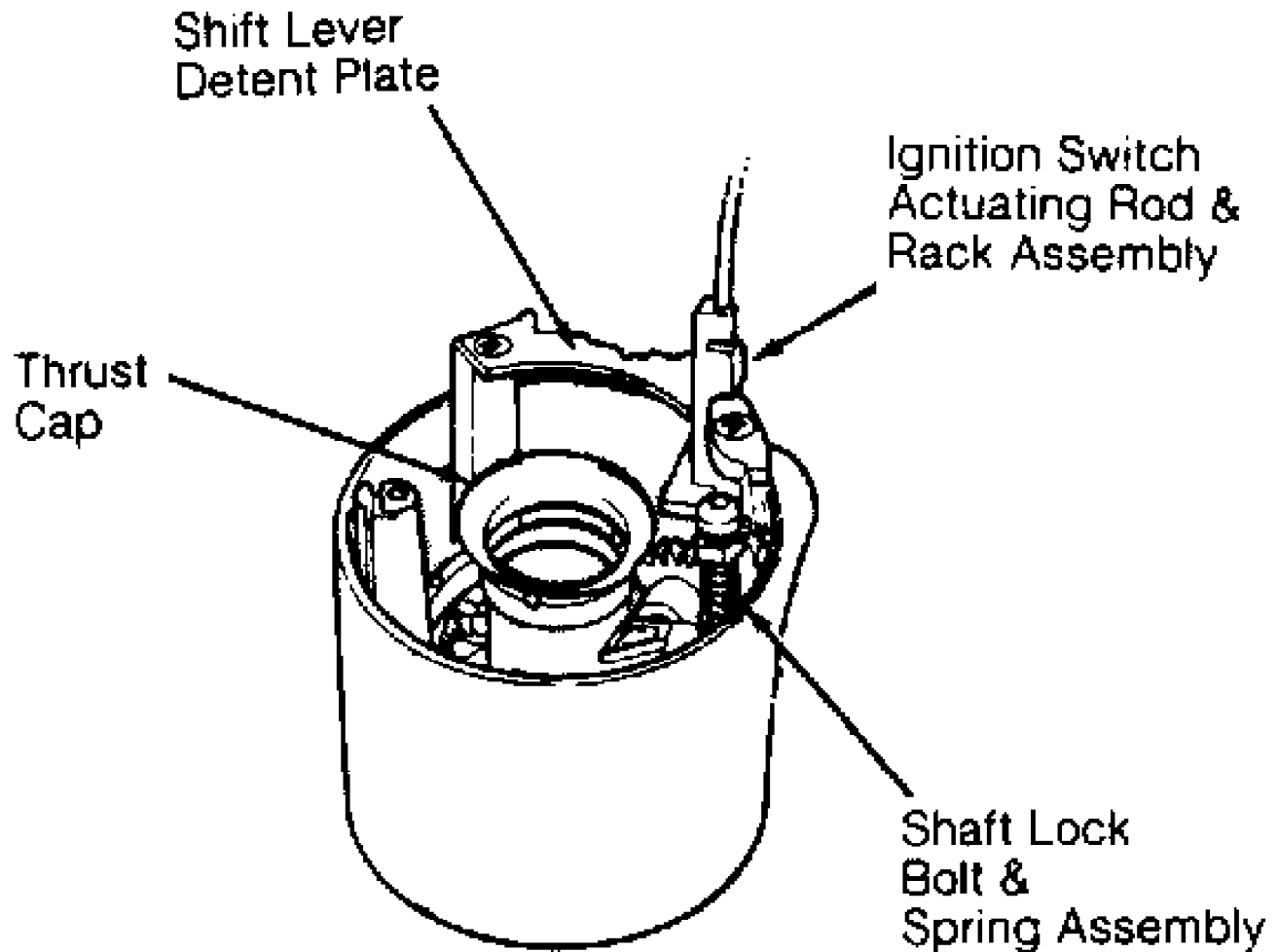


Fig. 4: Identifying Key/Lock Cylinder Housing  
Courtesy of Chrysler Corp.

8) Use punch to exert force on block tooth to disengage and remove lock sector. Remove gear selector lever housing and shroud from steering shaft. Remove gear selector lever spring from housing.

NOTE: Steering column must be removed from vehicle for further disassembly.

9) Remove steering shaft, if not removed earlier. Remove spring clip from lower bearing retainer, remove retainer, lower bearing, and adapter. Slide out shift tube.

10) On models equipped with floor shift, remove screws attaching key/lock cylinder and shroud to column jacket. Remove dimmer switch arm, disengage remote gear rod from lock rack. Remove key/lock cylinder housing to shroud screws and separate.

11) Remove and separate wave washer from key release lever



pivot. Remove lock rack, lock bolt and preload spring. Use punch to exert force on block tooth to disengage and remove lock sector. Remove gear selector lever housing and shroud from steering shaft.

12) Remove steering shaft, if not removed earlier. Remove spring clip from lower bearing retainer, remove retainer, lower bearing and adapter. Slide out shift tube.

#### Reassembly

1) Coat all friction surfaces with grease. Insert key sector through key/lock cylinder hole. Install lock sector shaft. Ensure sector turns freely. Install lock rack preload spring. Assemble lock bolt and rod and install assembly in housing. Mate assembly with lock sector gear teeth. Install shift lever detent plate on housing. See Fig. 5.

2) Install thrust cap and ignition switch actuating rod on housing. Insert gear selector lever housing lower bearing and align indentations in shell with projections on housing. Install gear selector spring in housing.

3) Install gear selector lever housing and shroud on column. Rotate housing to ensure that bearing is seated. With gear selector housing in Park position and lock rack pulled downward, position and seat key/lock cylinder housing on column. Tighten 4 screws to 40 INCH lbs. (4.5 N.m).

4) Insert shift tube in lower end of column and rotate until shift tube upper key slides into gear selector housing keyway. On models equipped with floor shift, proceed to step 10). On column shift models, proceed to next step.

5) Install key/lock cylinder housing and shroud on steering column, place key in ignition cylinder and rotate until key is aligned with keyway in housing. Insert cylinder into housing far enough to contact switch actuator. Press inward and rotate cylinder. When aligned, cylinder will move inward and spring-loaded retainer will snap into place. Cylinder is now locked in column.

6) Turn key/lock cylinder to ON position and install key/lock buzzer switch. Move ignition switch to ACC position then back 2 clicks to OFF position. The remote rod hole in ignition switch should be centered. Insert remote rod in ignition switch slider hole. Tighten ignition switch mounting screws to 35 INCH lbs. (4 N.m).

7) Install lower bearing, adapter, retainer and spring clip at lower end of column. Install steering shaft into lower end of column and route through into upper bearing. Position turn signal switch and wire harness in key/lock housing. Fold wires against connector and feed down through column. Install wiper wiring harness and route through column. Align and secure turn signal switch. Tighten screws to 35 INCH lbs. (4 N.m).

8) Install dimmer switch actuator arm and tighten screw to 35 INCH lbs. (4 N.m). Route cruise control wiring harness in column (if equipped). Install turn signal/wiper/dimmer/cruise control switch stalk on column by pressing straight in. Position thrust washer, upper bearing preload spring and cancel cam on steering column.

9) Install hazard warning switch knob. Place lock plate on shaft, depress lock plate with depressor and install new snap ring. Install steering wheel. See STEERING WHEEL & HORN PAD R & I. Tighten steering wheel nut to specification. See TORQUE SPECIFICATIONS.

10) On models equipped with floor shift, install key release lever return spring over threaded pivot post on housing. Insert key release finger in lock rack slot and position hole in lever over threaded pivot post. See Fig. 5. Ensure inner end of spring contacts release lever.

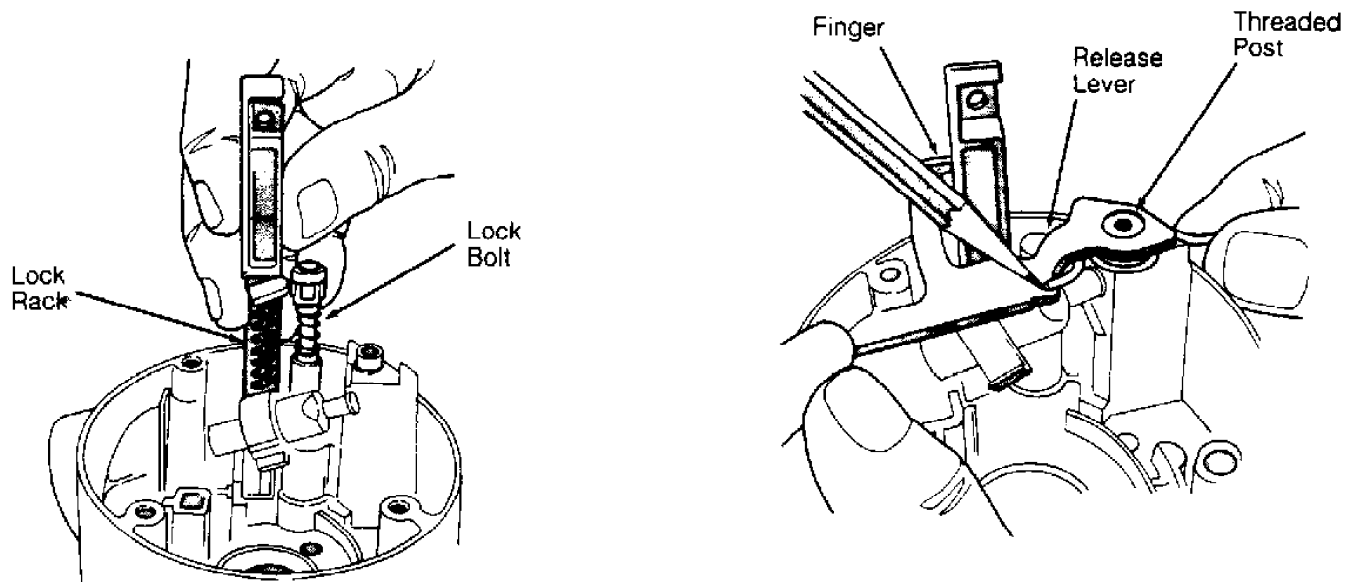


Fig. 5: Removing Lock Rack & Bolt Release Spring  
Courtesy of Chrysler Corp.

11) Raise key release lever slightly. Install lever spring between lever and boss on housing. Lubricate and place wave washer on threaded pivot post. Position shroud on key/lock housing. Tighten screws to 18 INCH lbs. (2 N.m).

12) Insert short, hooked end of remote rod in lock rack. Install assembled key/lock housing on steering column and tighten screws to 60 INCH lbs. (7 N.m). Install key/lock cylinder housing and shroud on steering column, place key in ignition cylinder and rotate until key is aligned with keyway in housing.

13) Insert cylinder into housing far enough to contact switch actuator. Press inward and rotate cylinder. When parts align, cylinder will move inward and spring-loaded retainer will snap into place. Cylinder is now locked in column.

14) Turn key/lock cylinder to ON position and install key/lock buzzer switch. Move ignition switch slider to ACC position, then back 2 clicks to OFF position. The remote rod hole in ignition switch should be centered. Insert remote rod in ignition switch slider hole and tighten ignition switch to column screws to 35 INCH lbs. (4 N.m).

15) Install lower bearing, adapter, retainer and spring clip at lower end of column. Install steering shaft into lower end of column and insert into upper bearing. Position turn signal switch and wire harness in key/lock housing. Fold wires against connector and feed down through column jacket. Install wiper wiring harness and route through column. Align and secure turn signal switch. Tighten screws to 35 INCH lbs. (4 N.m).

16) Install dimmer switch actuator arm and tighten screw to 35 INCH lbs. (4 N.m). Route cruise control wiring harness in column (if equipped). Install turn signal/wiper/dimmer/cruise control switch stalk on column by pressing straight in. Position thrust washer, upper bearing preload spring and canceling cam on steering column.

17) Install hazard warning switch knob. Place lock plate on shaft, compress plate and install new snap ring. Ensure that new snap ring is completely seated in groove before removing depressor. Install steering wheel. Tighten steering wheel nut to specification.

## TILT WHEEL COLUMN OVERHAUL

NOTE: Tilt steering can be disassembled in vehicle down to the column jacket. If further repairs are needed, column must be removed from vehicle.

#### Disassembly

1) Remove steering wheel. See STEERING WHEEL & HORN PAD R & I under REMOVAL & INSTALLATION. Remove column (if required). Attach column fixture and clamp assembly in vise. See Fig. 3.

2) Remove tilt release lever. To remove hazard warning knob, push in knob while unscrewing. Remove ignition key light assembly. Pull knob off wiper/washer switch assembly. Remove 2 sleeve-to-wiper/washer switch retaining screws and remove sleeve.

WARNING: Lock plate is retained by a very strong spring force.

DO NOT attempt to remove steering shaft snap ring without using appropriate lock plate depressor.

3) Rotate wiper switch shaft fully clockwise. Remove shaft by pulling straight out of wiper/washer switch. Carefully remove plastic cover from lock plate. Using Lock Plate Depressor (J-23653-A), depress lock plate. Pry retaining ring from groove, remove and discard ring.

4) Remove lock plate, canceling cam and upper bearing plate. Remove switch actuator screw and arm. Remove 3 turn signal switch attaching screws. Place shift bowl in LOW position. Wrap a piece of tape around wires to prevent snagging while removing switch and remove switch.

5) Turn key/lock cylinder to ON position. Using needle nose pliers, remove key warning buzzer switch and contacts as one unit. Remove spring and switch. DO NOT allow spring to fall into steering column. Insert a small screwdriver into the right-hand slot adjacent to switch attaching screw boss. Depress spring latch located at bottom of slot and remove key/lock cylinder.

6) Remove 3 key/lock cylinder housing cover screws and remove housing cover. Remove wiper/washer switch. Tilt lever opening shield and dimmer switch actuator rod may be removed from cap (if necessary). Remove dimmer switch mounting screws and remove switch. With ignition switch in ACC position, remove ignition switch mounting screws and remove switch.

WARNING: Tilt spring guide retainer has strong spring force.

7) Remove upper bearing race and bearing seat from steering shaft. Place column in full upward tilt position. Using a large Phillips head screwdriver, press tilt spring guide inward and turn counterclockwise until retainer tabs disengage from key/lock housing lug.

8) Place column in center most position. Place Pivot Pin Remover (J-21854-01) over pivot pin. Thread small portion of screw firmly into pin. Hold screw from turning with one wrench while turning nut clockwise with a second wrench to withdraw pivot pin from support.

9) Remove opposite pivot pin in same manner. Use tilt release lever to disengage lock shoes. Remove bearing housing assembly by pulling upward to extend rack fully. Move housing assembly to the left to disengage rack from actuator.

10) Rotate housing clockwise to free dimmer switch actuator rod. Remove actuator assembly. Remove lock sector spring retaining screw and sector spring. Remove lock bolt, lock rack, rack preload spring and remote rod from key/lock cylinder housing.

11) Insert a wedge between lock shoes and key/lock cylinder housing to relieve spring tension tilt release lever pin and lock shoe pin. Using a punch, remove tilt release lever pin and lock shoe pin. Remove lock shoes, spring and wedge. Remove upper and lower bearings and races from key/lock cylinder housing if required.

NOTE: Bearings and races only require removal if damaged. Remove races with hammer and punch and discard. DO NOT reuse components.

12) Remove steering shaft from upper end of steering column. Separate upper and lower steering shaft by folding shaft 90 degrees at flex joint and detaching shaft sections. See Fig. 6. Remove steering column support from column. Remove shift gate from steering support (if required).

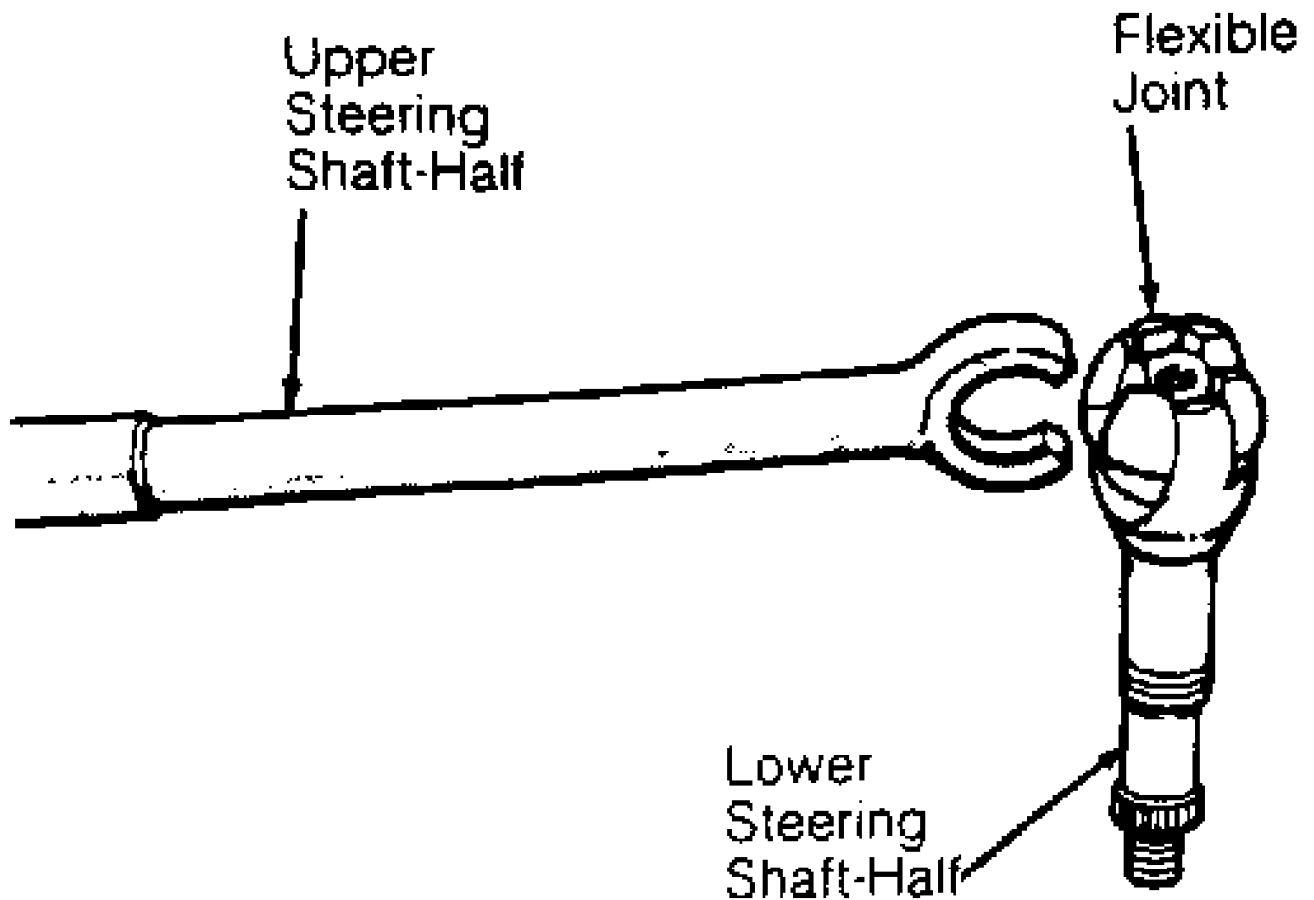


Fig. 6: Identifying Tilt Column Flexible Joint  
Courtesy of Chrysler Corp.

13) Remove retainer and bearing from lower end of steering column. Remove shift tube retaining ring and thrust washer. Using Puller (J-23072), remove shift tube from bowl. Insert bushing on end of puller in shift tube to force tube from bowl. DO NOT hammer shift tube as plastic joints may shear. See Fig. 7.

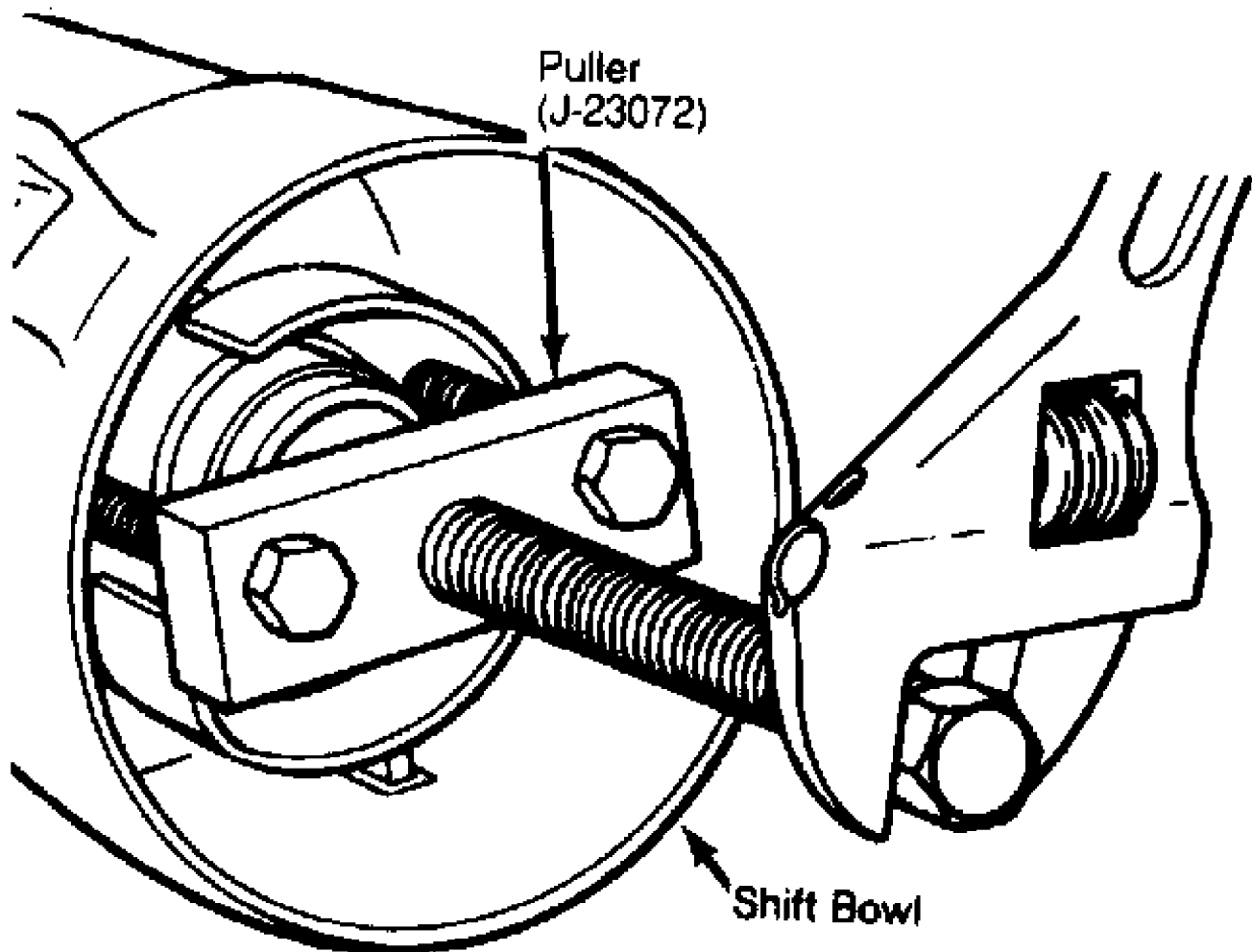


Fig. 7: Removing Shift Tube from Bowl (Tilt Wheel)  
Courtesy of Chrysler Corp.

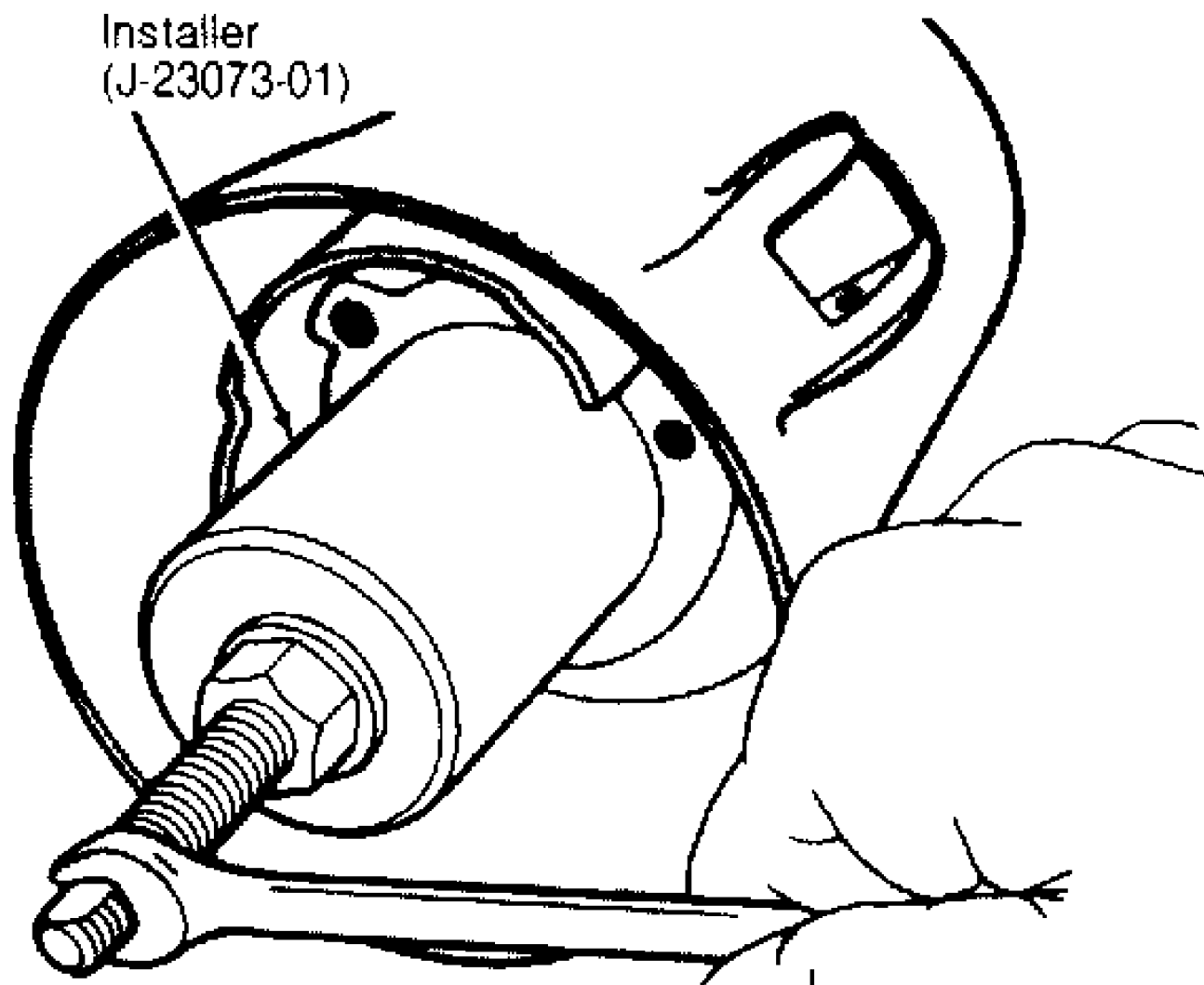
14) Tilt upper end of retainer plate toward lower end of column, turn plate counter-clockwise and remove. On column shift models, remove wave washer and shift tube spring. Remove shift bowl from steering column jacket. On floor shift models, remove column shroud from column jacket. Remove key release lever and spring from column shroud.

**WARNING:** Use only original or exact replacement screws, bolts and nuts to assemble steering column. Use of incorrect hardware could keep column from compressing in a collision. Column-to-instrument panel attaching nuts **MUST** be tightened to correct torque so that column will break away on impact.

#### Reassembly

1) During reassembly, coat all friction surfaces with multipurpose grease. If reassembling a floor shift type column, proceed to step 3). To reassemble column shift type column, install shift bowl on steering column jacket. Install shift tube spring, wave washer and retainer plate in shift bowl. Insert shift tube through lower end of column jacket and align tube key spline with shift bowl keyway.

2) Install Installer (J-23073-01) and pull shift tube into bowl. See Fig. 8. Install shift tube thrust washer and retainer plate snap ring. Install column lower bearing. Attach shift gate to steering column support. Install steering column support assembly into column and tighten retaining screws alternately and evenly to 60 INCH lbs. (7 N.m).



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Fig. 8: Installing Shift Tube (Tilt Wheel)  
Courtesy of Chrysler Corp.

3) To reassemble floor shift type column, position key release lever spring onto lever and install assembly into column shroud. Install shroud onto steering column jacket. Install retainer plate into column jacket notches.

4) Install column support into column jacket by aligning "V" on support with "V" notch in column jacket. To completely seat support, press key release lever downward while pressing support into place. Install steering column support retaining screws and tighten alternately and evenly to 60 INCH lbs. (7 N.m).

NOTE: Remaining steps apply to either column shift type or floor shift type columns.

5) Install remote rod in column support rod slot. Install dimmer and ignition switches. Install new races and bearings in key/lock cylinder housing if old components were removed. Using a .18" (4.5 mm) diameter rod to aid in alignment, install lock shoes, lock shoe springs and lock shoe pin.

6) Install tilt release lever, lever spring and lever pin in key/lock cylinder housing. Insert wedge between housing and lever to relieve spring tension and ease pin installation.

7) Install lock bolt in key/lock cylinder housing and engage it in lock sector cam surface. Install lock rack, rack preload spring and replacement shim in key/lock cylinder housing. Mate square block tooth on lock rack to like tooth on lock sector. Tighten screws to 35 INCH lbs. (4 N.m).

8) Retain lock shoes in disengaged position and install key/lock housing on column support. Align pivot pin holes in key/lock cylinder housing with those in column support and install pivot pins. Seat pins fully using a hammer and punch.

CAUTION: Press housing down firmly while installing pivot pins to avoid damage to holes in column support.

9) Place key/lock cylinder housing in full upward tilt position. Lubricate tilt spring guide and spring with chassis lube. Insert tilt spring guide and spring into key/lock cylinder housing. Using a large Phillips head screwdriver, install spring retainer into key/lock cylinder housing lugs.

10) Install key/lock cylinder housing cover and tighten screws to 60 INCH lbs. (7 N.m). Install gear selector indicator light assembly (if equipped). Route dimmer switch harness down through column.

11) Insert key/lock cylinder into housing far enough to contact switch actuator. Press inward and rotate cylinder. When aligned, cylinder will move inward and spring-loaded retainer will snap into place. Cylinder is now locked in column. Turn key/lock cylinder to ON position. Install key/lock buzzer switch.

12) Install turn signal switch, but DO NOT install switch retaining screws at this time. Install windshield wiper harness and switch and route harness down through column jacket. Route cruise control harness (if equipped), down through column jacket.

13) Install turn signal switch stalk by pushing straight into column. Install hazard warning knob on hazard warning switch. Install turn signal retaining screws and tighten to 35 INCH lbs. (4 N.m). Install upper bearing race in key/lock cylinder housing.

14) Install cruise control harness (if equipped). Install upper bearing preload spring, canceling cam and lock plate. Depress lock plate with depressor and install new snap ring. See Fig. 9. Install lock plate cover. Install gear selector lever and retaining pin (if equipped).

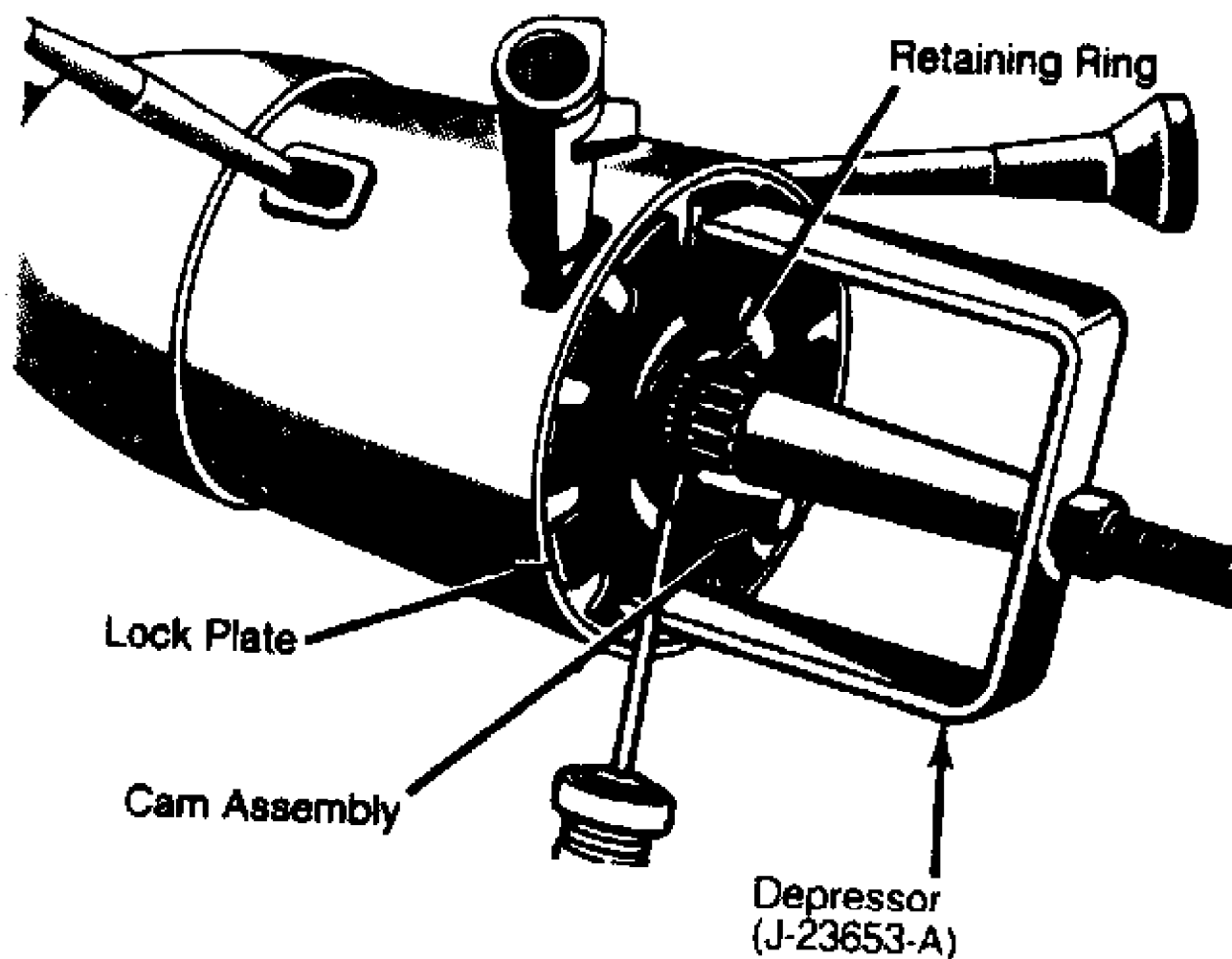


Fig. 9: Installing Lock Plate Retaining Ring  
Courtesy of Chrysler Corp.

15) Install steering wheel. See STEERING WHEEL & HORN PAD R & I under REMOVAL & INSTALLATION. Turn key/lock cylinder to OFF position, move ignition switch downward to eliminate lash, and install switch retaining screws. Tighten screws to 35 INCH lbs. (4 N.m).

16) Depress dimmer switch slightly and insert 3/32" drill bit into adjustment hole. Loosen retaining screws, move switch upward to remove lash, and retighten screws to 35 INCH lbs. (4 N.m). Remove drill bit and test dimmer switch operation in all column tilt positions.

17) Install steering column. See appropriate type column under REMOVAL & INSTALLATION. Reconnect negative battery cable. Test ignition switch in all tilt positions. Ensure vehicle starts only in Park and Neutral.

## TORQUE SPECIFICATIONS

### CHEROKEE

#### TORQUE SPECIFICATIONS (CHEROKEE)

Application

Ft. Lbs. (N.m)



Column Mounting Bracket Bolt .....	15 (20)
Flexible Coupling Bolt .....	25 (34)
Steering Wheel Retaining Nut .....	25 (34)

INCH Lbs. (N.m)

Bearing Housing-To-Lock Housing Screw .....	35 (4)
Column Clamp Stud .....	20 (2)
Column Clamp Stud Nut .....	106 (12)
Dimmer Switch .....	35 (4)
Hazard Switch Knob Screw .....	27 (3)
Housing Cover Screw .....	100 (11)
Ignition Switch Screw .....	35 (4)
Lock Housing-To-Jacket Screw .....	90 (10)
Shift Tube Support Screw .....	60 (7)
Steering Column Lower Bracket Bolt .....	106 (12)
Tilt Release Spring Retaining Screw .....	35 (4)
Toe Plate .....	66 (7)
Turn Signal Retaining Plate Screw .....	33 (4)

## GRAND CHEROKEE & GRAND WAGONEER

### TORQUE SPECIFICATIONS (GRAND CHEROKEE & GRAND WAGONEER)

Application	Ft. Lbs. (N.m)
Flexible Coupling Bolt .....	25 (34)
Intermediate Shaft Pinch Bolt .....	35 (47)
Steering Wheel Retaining Nut .....	45 (61)

INCH Lbs. (N.m)

Bearing Housing-To-Lock Housing Screw .....	35 (4)
Column Clamp Stud .....	20 (2)
Column Clamp Stud Nut .....	106 (12)
Dimmer Switch .....	35 (4)
Hazard Switch Knob Screw .....	27 (3)
Housing Cover Screw .....	100 (11)
Ignition Switch Screw .....	35 (4)
Lock Housing-To-Jacket Screw .....	90 (10)
Shift Tube Support Screw .....	60 (7)
Steering Column Lower Bracket Bolt .....	106 (12)
Tilt Release Spring Retaining Screw .....	35 (4)
Toe Plate .....	105 (12)
Turn Signal Retaining Plate Screw .....	33 (4)
Upper Bracket Nut .....	106 (12)

## WRANGLER

### TORQUE SPECIFICATIONS (WRANGLER)

Application	Ft. Lbs. (N.m)
Column Mounting Bracket Bolt .....	21 (28)
Flexible Coupling Bolt .....	25 (34)
Steering Wheel Retaining Nut .....	25 (34)

INCH Lbs. (N.m)

Bearing Housing-To-Lock Housing Screw .....	35 (4)
---	--------

Column Clamp Stud .....	20	(2)
Column Clamp Stud Nut .....	106	(12)
Dimmer Switch .....	35	(4)
Hazard Switch Knob Screw .....	27	(3)
Housing Cover Screw .....	100	(11)
Ignition Switch Screw .....	35	(4)
Lock Housing-To-Jacket Screw .....	90	(10)
Shift Tube Support Screw .....	60	(7)
Steering Column Lower Bracket Bolt .....	106	(12)
Tilt Release Spring Retaining Screw .....	35	(4)
Toe Plate .....	192	(22)
Turn Signal Retaining Plate Screw .....	33	(4)

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# STEERING KNUCKLES - 4WD

## 1993 Jeep Cherokee

1993 DRIVE AXLES  
Chrysler Corp. 4WD Steering Knuckles

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION

Open-end steering knuckles pivot on ball joints and allow wheels to turn.

### REMOVAL & INSTALLATION

#### Removal

1) Raise and support vehicle. Remove wheel, disc brake caliper, rotor, cotter pin, nut retainer, and axle hub nut. Remove hub-to-steering knuckle attaching bolts. Remove hub and rotor shield from steering knuckle. Remove axle shaft from axle tube. See FRONT AXLES article.

NOTE: DO NOT disconnect caliper unless service is needed. Support caliper with wire to prevent hose damage.

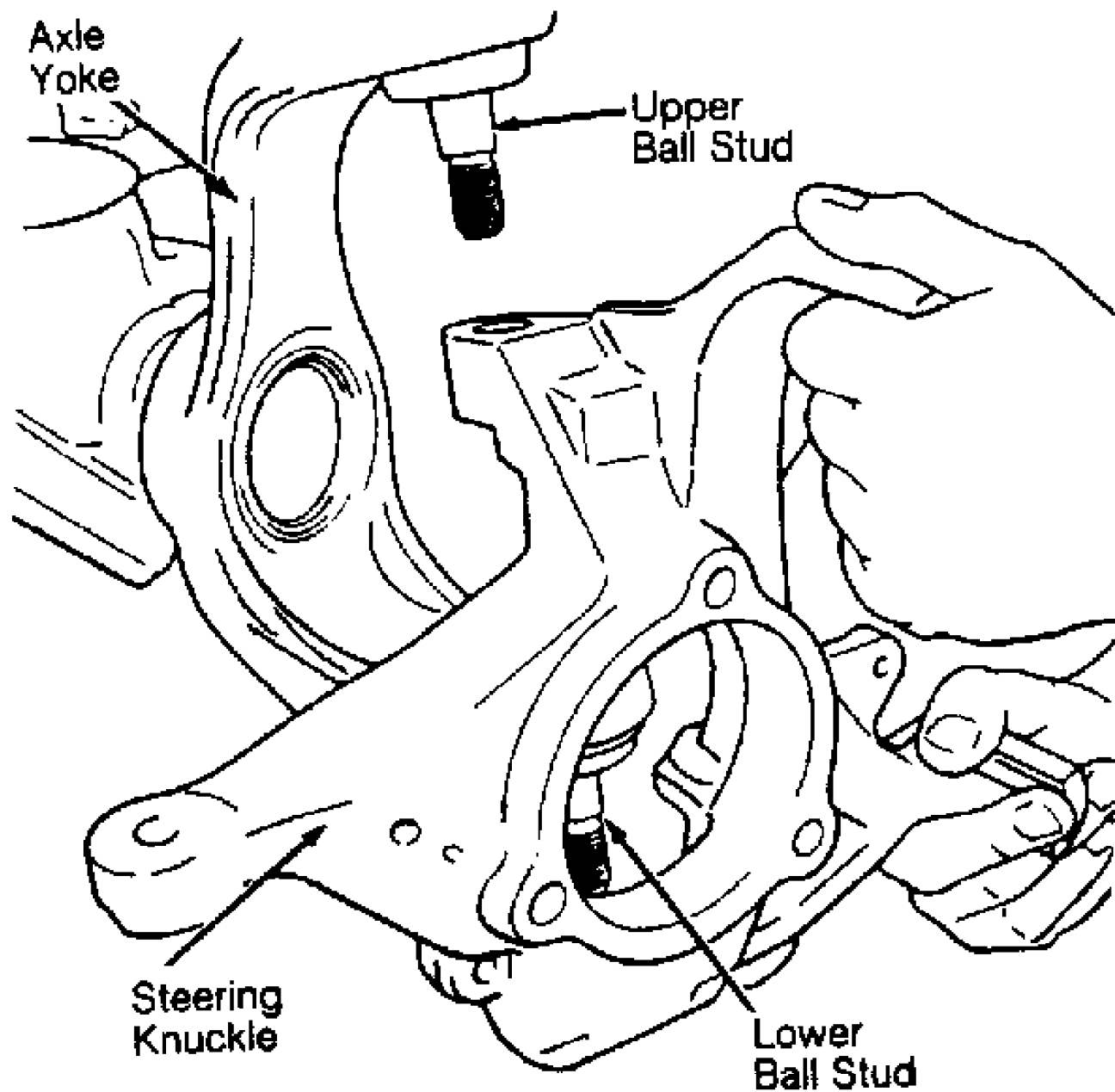
2) On models with front axle shift motor, remove outer axle shaft from right axle tube. Leave shift collar on intermediate shaft. Remove caliper anchor plate from steering knuckle. Remove steering knuckle and ball joint cotter pins. Remove ball joint nuts. Strike steering knuckle at ball joint stud boss with a brass hammer to loosen knuckle from ball joint studs. Remove steering knuckle.

#### Installation

1) Position steering knuckle over ball joint studs and install nuts. See Fig. 1. Install NEW cotter pins. Install caliper anchor plate and tighten bolts to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Install axle shafts into axle tubes.

2) On vehicles with front axle shift motor, ensure shift collar is correctly positioned on intermediate axle shaft. Install axle into shift collar inside axle tube. Ensure axle shaft is completely engaged with shift collar.

3) On all models, apply bearing grease to spindle hub bore in steering knuckle and install rotor shield and hub. Tighten spindle hub bolts. Install hub washer and nut. Tighten hub nut to specification. Install hub nut retainer and NEW cotter pin. Install rotor, caliper and wheel. Lower vehicle.



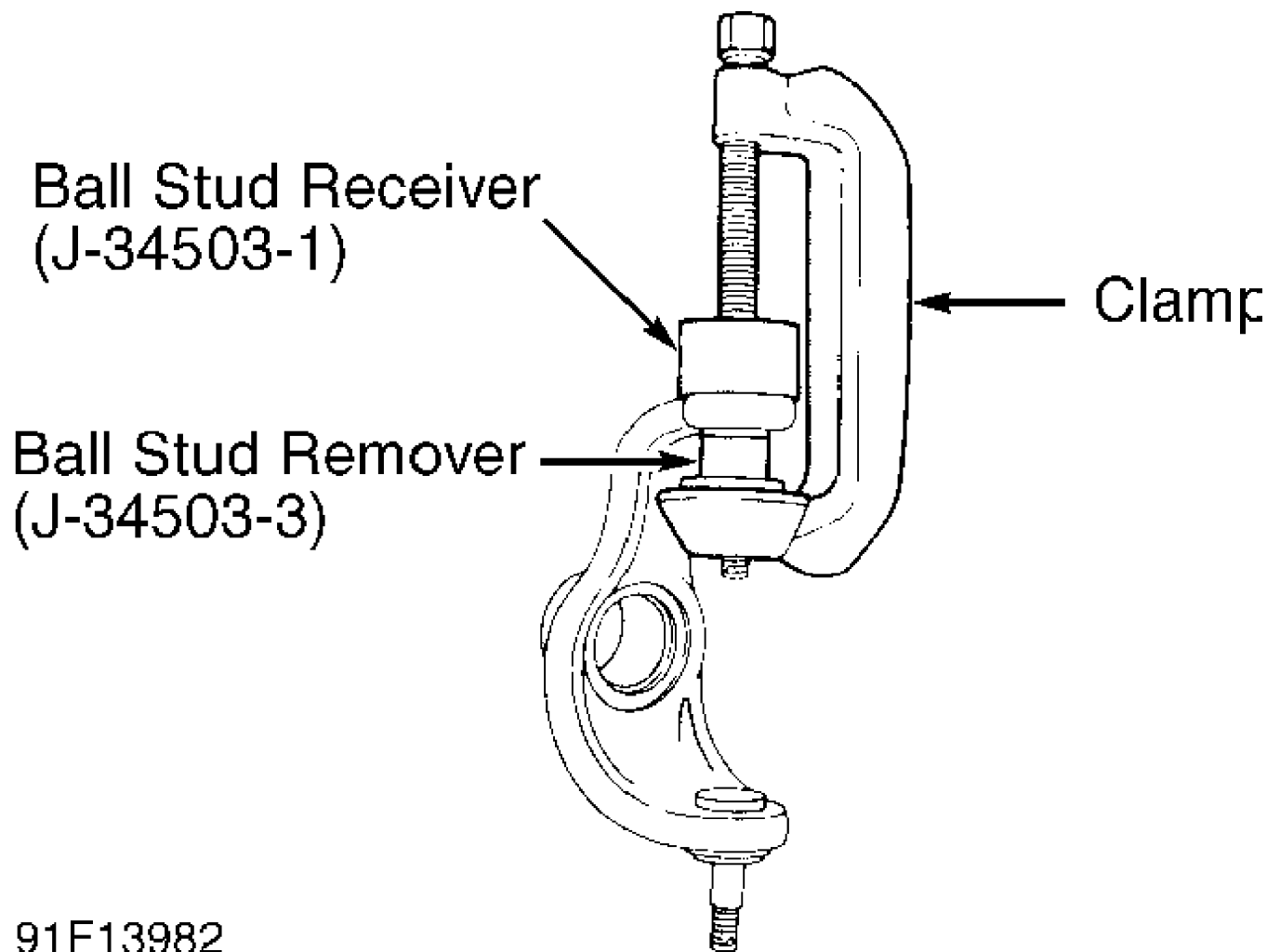
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Fig. 1: Removing & Installing Steering Knuckle Assembly  
Courtesy of Chrysler Corp.

## OVERHAUL

### Removal (Upper Ball Joint)

Place steering knuckle in soft-jawed vise, place Receiver (J-34503-1) on top of upper ball joint. Place Ball Stud Remover (J-34503-3) in "C" clamp. Place "C" clamp and remover under upper ball joint and tighten "C" clamp screw to remove ball joint. See Fig. 2.

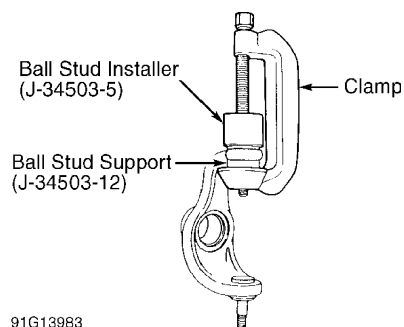


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Fig. 2: Removing Upper Ball Joint  
Courtesy of Chrysler Corp.

#### Installation (Upper Ball Joint)

Place Ball Stud Installer (J-34503-5) on top of upper ball joint. Place Ball Stud Support (J-34503-12) between "C" clamp and yoke. Tighten "C" clamp screw and seat ball joint. See Fig. 3



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Fig. 3: Installing Upper Ball Joint  
Courtesy of Chrysler Corp.

#### Removal (Lower Ball Joint)

Place Ball Stud Receiver (J-34503-1) on "C" clamp screw and

Ball Stud Remover (J-34503-3) between top of yoke and "C" clamp. Press lower ball joint into receiver.

Installation (Lower Ball Joint)  
Place Installation Cup (J-34503-4) on "C" clamp screw and Ball Stud Support (J-34503-12) between top of yoke and "C" clamp. Tighten "C" clamp screw until lower ball joint is seated in yoke.

**TORQUE SPECIFICATIONS**

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Ball Joint Nuts .....	75 (102)
Caliper Anchor Plate .....	77 (104)
Spindle Hub Bolts .....	75 (102)
Axle Hub-To-Shaft nut .....	175 (237)
Wheel Lug Nuts	
Except Grand Cherokee .....	80 (108)
Grand Cherokee .....	88 (120)

# STEERING SYSTEM - POWER

## 1993 Jeep Cherokee

1993 STEERING

Chrysler Corp. Power Steering - Recirculating Ball

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION & OPERATION

NOTE: This article has been revised as per TSB # 19-02-93 dated Feb. 22, 1993. For specific revision information, see TORQUE SPECIFICATIONS (GRAND CHEROKEE & GRAND WAGONEER).

Steering gear is a variable ratio, recirculating ball type. Power assist is provided by a belt driven hydraulic pump. Control valves are located inside steering gear housing.

Two types of Saginaw vane-type power steering pumps are used to provide hydraulic pressure for a recirculating ball type steering gear. Some applications utilize a pump submerged in reservoir housing. Other applications are equipped with a remote reservoir, mounted on left fender apron. See POWER STEERING PUMP APPLICATIONS table. Manufacturer does not recommend overhaul of power steering pump. If service is required, pump must be replaced as an assembly.

Pump vanes are driven by a rotor and move fluid from the intake to the pressure cavities of pump ring. Centrifugal force moves vanes against inside surface of pump ring to pick up residual oil. As more oil is picked up, it is forced into cavities of thrust plate, into 2 crossover holes in pump ring and pressure plate, and into a high pressure area between pressure plate and housing end plate.

Filling the high pressure area causes oil to flow under the vanes in slots of the rotor. This forces vanes to follow inside oval surface of pump ring. As vanes rotate to small area of pump ring, oil is forced out from between vanes.

#### POWER STEERING PUMP APPLICATIONS TABLE

Application	Type
Cherokee	
2.5L .....	Non-Submerged
4.0L .....	Submerged
Grand Cherokee & Grand Wagoneer .....	Submerged
Wrangler .....	Non-Submerged

### FLUID TYPE

Use Mopar power steering fluid.

### FLUID LEVEL CHECK

Check power steering fluid level using dipstick attached to reservoir cap. Check fluid with engine stopped. Depending on fluid temperature, level should be at HOT or COLD mark on dipstick.

### HYDRAULIC SYSTEM BLEEDING

1) Fill reservoir. Operate engine until fluid reaches operating temperature of 170°F (77°C). Turn wheels to full left position. Check fluid, adding if necessary.

2) Start engine, and operate it at fast idle. Recheck

reservoir level. Add fluid if necessary. Turn wheels from side to side without contacting stops. Maintain fluid level just above pump body.

3) After air is removed, return wheels to straight-ahead position. Run engine 2-3 minutes. Road test vehicle. Recheck fluid level.

## TROUBLE SHOOTING

Refer to TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

## ADJUSTMENTS

### POWER STEERING PUMP BELT

Using belt tension gauge, check power steering belt tension. See BELT TENSION SPECIFICATIONS table. If adjustment is required, loosen power steering pump rear mounting bolts (if equipped). Loosen pivot bolt. Tighten adjuster bolt to increase belt tension; loosen adjuster bolt to decrease belt tension. Tighten mounting and pivot bolts. Recheck belt tension.

BELT TENSION SPECIFICATIONS TABLE (1)

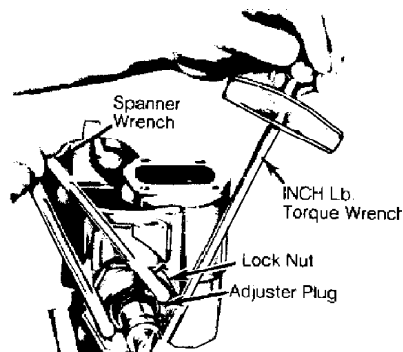
Application	New Belt: Lbs. (kg)	Used Belt: Lbs. (kg)
Serpentine Belt .....	180-200 .....	140-160 .....

(1) - Tension specifications in lbs. using Burroughs tension gauge.

### WORM SHAFT THRUST BEARING PRELOAD

**CAUTION:** Always adjust worm shaft bearing preload before adjusting sector shaft over-center preload torque.

1) Remove steering gear from vehicle. See STEERING GEAR R & I under REMOVAL & INSTALLATION. Rotate gear lock-to-lock several times to drain fluid. Remove adjuster plug lock nut. See Fig. 1. Using spanner wrench, turn adjuster plug clockwise until plug is firmly seated in housing.



30539  
Fig. 1: Measuring Thrust Bearing Preload  
Courtesy of Chrysler Corp.

2) Index mark housing opposite one hole in adjuster plug. Measure about 1/2" (13 mm) counterclockwise from mark. Mark housing.



Rotate plug counterclockwise until hole in adjuster aligns with second mark.

3) Tighten lock nut to 80 ft. lbs. (108 N.m). Ensure adjuster plug remains in position. Attach INCH-lb. torque wrench to end of stub shaft. Turn stub shaft to right stop, then back 1/4 turn.

4) Using torque wrench, measure rotational torque required to turn shaft. Take reading with handle of torque wrench nearly vertical while turning it counterclockwise at an even rate. On Cherokee and Wrangler models, reading should be 4-10 INCH lbs. (.5-1.1 N.m). On Grand Cherokee and Grand Wagoneer models, readings should be 6-10 INCH lbs. (.6-1.1 N.m),

5) If torque reading is not within specification, adjustment cap may not be correctly adjusted, steering gear may be assembled incorrectly or thrust bearings and races may be defective.

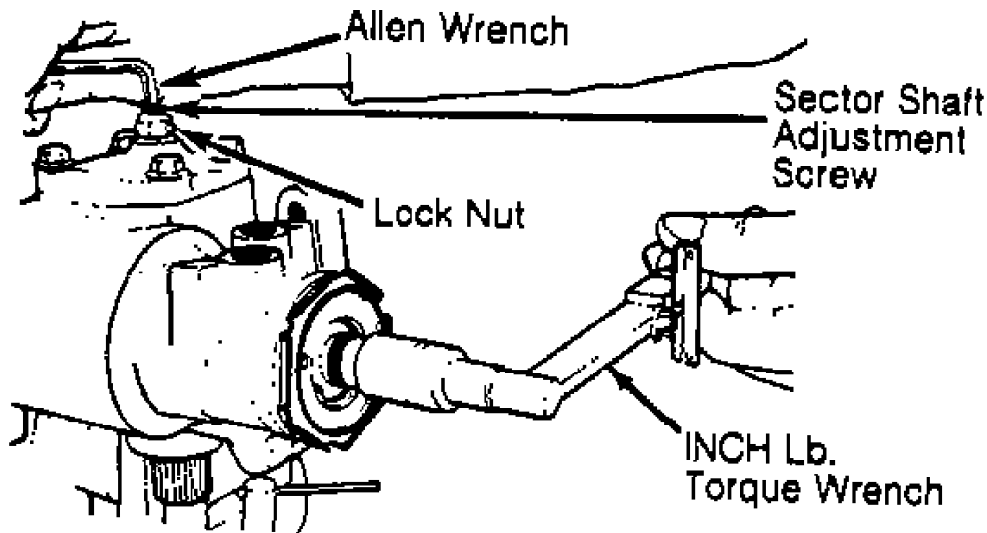
### SECTOR SHAFT OVER-CENTER PRELOAD

**CAUTION:** Always adjust worm shaft bearing preload before adjusting sector shaft over-center preload torque.

1) Rotate stub shaft from stop-to-stop and count turns. To center steering gear, rotate shaft in reverse direction 1/2 number turned during stop-to-stop. Attach an INCH-lb. torque wrench to stub shaft. Measure sector shaft over-center preload torque by turning torque wrench in a 45-degree arc on each side of vertical center. Record highest over-center rotational torque reading.

2) Rotational torque required to turn stub shaft should be 6-10 INCH lbs. (.6-1.2 N.m) greater than rotational torque specified for worm shaft. See WORM SHAFT THRUST BEARING PRELOAD.

3) If adjustment is necessary, loosen adjustment on sector shaft adjuster screw until shaft has no preload. See Fig. 2. Tighten adjuster screw until required preload is obtained. Ensure adjustment screw does not move and tighten adjuster screw lock nut to 36 ft. lbs. (49 N.m). Recheck preload.



30540

Fig. 2: Adjusting Over-Center Preload  
Courtesy of Chrysler Corp.

### TESTING

## HYDRAULIC SYSTEM PRESSURE TEST

1) With belt tension correct, disconnect power steering pump pressure hose. Keep hose end raised to prevent fluid loss. Install Pressure Tester (7617) between power steering pump and steering gear.

2) Open valve. Run engine until fluid reaches normal operating temperature of 170°F (77°C). Check fluid level. Add fluid if necessary.

3) Note pressure reading with valve open and engine idling. Pressure should be less than 125 psi (9 kg/cm<sup>2</sup>). If pressure exceeds 125 psi (9 kg/cm<sup>2</sup>), check hoses for restrictions and poppet valve for proper assembly.

4) Close and reopen the gate valve completely 3 times. Record the highest reading each time. DO NOT close valve longer than 5 seconds. Note if pressure is within specification. Refer to the PRESSURE TEST SPECIFICATIONS table.

5) If all readings are within specification and 50 psi (3.5 kg/cm<sup>2</sup>) of each other, pump operation is normal.

6) If readings exceed specification or are not within 50 psi (3.5 kg/cm<sup>2</sup>) of each other, flow control valve in pump is sticking. Remove flow control valve. Clean or replace valve as necessary.

7) If readings are below specification, clean or replace flow control valve. If pressures are still low, replace pump.

8) If readings are all within specification, open valve and turn steering wheel from right stop to left stop. Record pressure. DO NOT hold wheel against stops longer than 5 seconds.

9) Compare both readings to pump output pressure reading obtained. Readings should be same as pump output pressure. If readings are low, steering gear is leaking internally. Repair or replace as required.

### PRESSURE TEST SPECIFICATIONS TABLE

Application	Idle: psi (kg/cm <sup>2</sup> )	Relief: psi (kg/cm <sup>2</sup> )
Except Wrangler	Less Than 125 (9)	1350-1450 (95-102)
Wrangler	Less Than 125 (9)	1050-1150 (74-81)

## REMOVAL & INSTALLATION

### POWER STEERING PUMP R & I

#### Removal & Installation

1) Loosen and remove pump drive belt. Place pan under power steering pump. Disconnect pressure and return hoses from pump. If equipped with remote reservoir, drain reservoir and remove supply hose from pump. Cap ends to prevent excessive fluid loss or contamination.

2) Remove bracket-to-engine bolts. Remove pivot bolt. Remove pump and mounting bracket as an assembly. To install, reverse removal procedure. Fill and bleed system. See HYDRAULIC SYSTEM BLEEDING under LUBRICATION.

### STEERING GEAR R & I

#### Removal

1) Center steering gear. Disconnect intermediate shaft. Raise and support vehicle. Place drain pan under steering gear assembly. Disconnect hydraulic hoses from gear. Cap ends to prevent excessive fluid loss or contamination. Disconnect steering linkage from pitman arm.

2) Remove pitman arm from gear. Remove flexible coupling clamp bolt. Remove steering gear-to-frame bolts. Remove gear from flexible coupling and frame.

#### Installation

To install, reverse removal procedure. Fill pump reservoir. Bleed air from system. See HYDRAULIC SYSTEM BLEEDING under LUBRICATION.

### TIE ROD END R & I

#### Removal & Installation

1) Remove cotter pins and retaining nuts at tie rod end. See Figs. 3 and 4. If necessary, disconnect steering damper from tie rod. Using puller, separate tie rod end from steering knuckle or steering linkage.

2) Loosen clamp bolts at adjusting sleeve. Remove tie rod end from adjusting sleeve. Note number of turns required to remove tie rod end for installation reference.

3) To install, reverse removal procedure. Install adjusting sleeve clamp bolts with threaded end of bolt toward rear of vehicle and angled slightly upward. Check and adjust toe-in. Refer to the WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

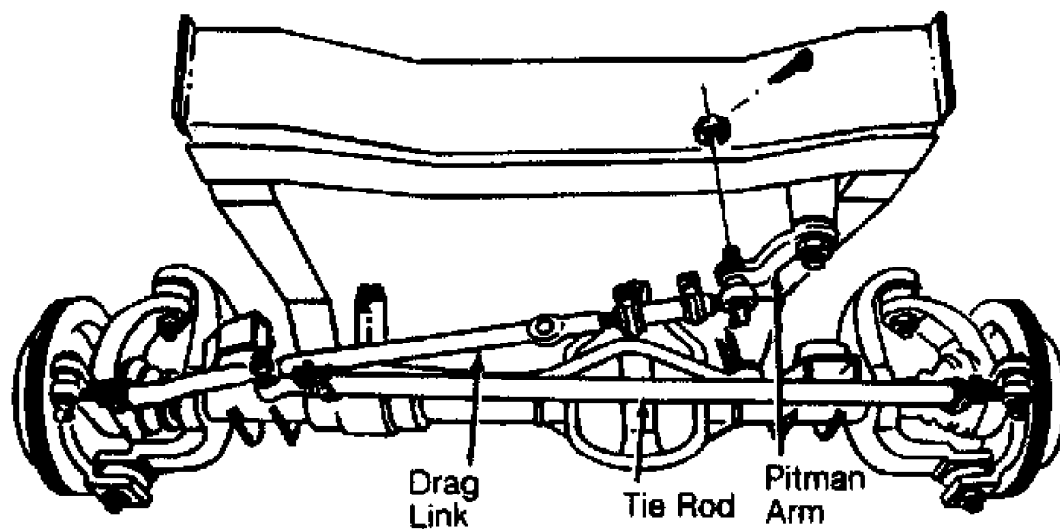


Fig. 3: Steering Linkage Component ID (Except Wrangler)  
Courtesy of Chrysler Corp.

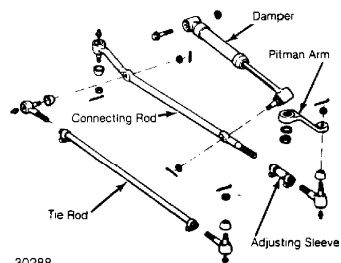


Fig. 4: Exploded View Of Steering Linkage (Wrangler)  
Courtesy of Chrysler Corp.

### STEERING DAMPER R & I

### Removal & Installation

Place front wheels in straight-ahead position. Remove cotter pins and retaining nuts and bolts at ends of damper and steering linkage. See Figs. 3 and 4. Remove damper assembly and rubber bushings. To install, reverse removal procedure.

## DRAG LINK R & I

### Removal & Installation

Raise and support vehicle. Separate steering damper from drag link. See Figs. 3 and 4. Remove cotter pins and nuts from both ends of drag link. Using a puller, separate drag link from steering linkage. To install, reverse removal procedure. Before installation, ensure wheels are in straight ahead position and pitman arm is centered.

## OVERHAUL

### STEERING GEAR OVERHAUL

#### Disassembly

1) Cap all openings in gear. Clean gear exterior completely. Mount gear in vise so sector shaft points downward. See Fig. 5. Rotate housing end plug retainer ring until one end of plug is over hole in housing.

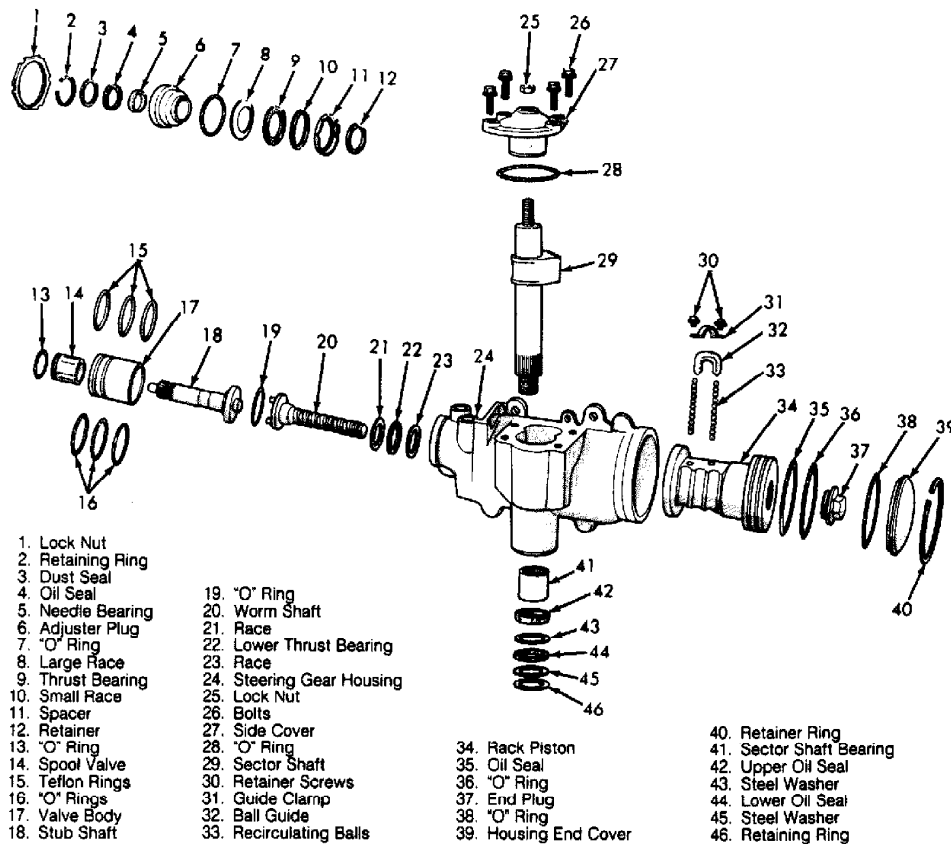


Fig. 5: Exploded View Of Saginaw Rotary Valve Power Steering Gear  
Courtesy of Chrysler Corp.

2) Force end of housing end cover retaining ring from groove in housing. Remove ring. Rotate stub shaft counterclockwise to force

housing end cover from housing. Rotate stub shaft clockwise 1/2 turn to draw rack piston inward.

CAUTION: DO NOT rotate stub shaft more than necessary to remove plug as ball bearings will fall out of worm and rack piston assembly.

3) Remove end plug. Remove lock nut from sector shaft adjuster. Remove side cover. Remove and discard "O" ring or gasket from cover. Turn stub shaft until sector shaft teeth are centered in housing.

4) Using a soft-faced hammer, tap end of sector shaft to free shaft from housing. Remove sector shaft. Remove adjuster plug lock nut. Using a spanner wrench, remove adjuster plug.

5) Insert Rack Piston Arbor (C-4175) into end of rack piston assembly until arbor contacts worm shaft. Threaded arbor keeps recirculating balls from falling out of rack piston. Turn stub shaft counterclockwise to force rack piston onto arbor. Remove rack piston and arbor as an assembly.

6) Take care to keep arbor fully inserted so recirculating balls do not fall out. Remove stub shaft and valve body from housing. Remove worm shaft, worm shaft lower thrust bearing and washers from housing.

#### Inspection

1) Clean all internal parts in solvent, and dry with compressed air. DO NOT steam clean hydraulic parts. Avoid wiping valve parts with cloth. Lint may cause binding of mechanism.

2) If further disassembly is required, see the following:

- \* ADJUSTER PLUG OVERHAUL.
- \* RACK PISTON & WORM SHAFT ASSEMBLY OVERHAUL.
- \* VALVE BODY ASSEMBLY OVERHAUL.
- \* HOUSING ASSEMBLY OVERHAUL.

#### Reassembly

1) Lubricate all parts with power steering fluid before reassembly. Install lower thrust bearing and washers on worm shaft. See Fig. 6.

NOTE: If conical thrust washers are used, ensure tapered surfaces are parallel to each other and cupped sides face toward stub shaft.

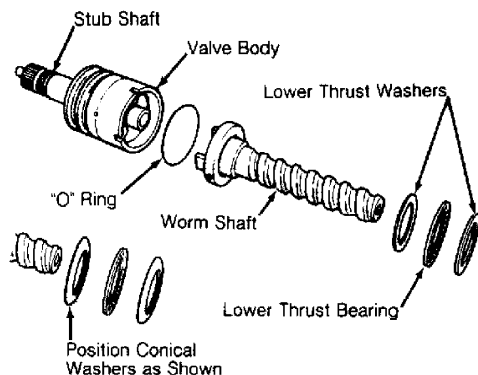


Fig. 6: Exploded View Of Valve Body & Worm Shaft Assembly  
Courtesy of Chrysler Corp.

2) Place worm shaft in valve body. Install NEW "O" ring in valve body. Align notch in valve body with pin in worm shaft. Install

valve body and worm assembly into housing. Installation is correct when fluid return port in housing is fully visible.

3) Place seal protector over stub shaft. Using NEW "O" ring, install adjuster plug until it seats against valve body. Remove seal protector from housing.

4) Loosely install adjuster plug lock nut. Insert rack piston (with arbor to retain recirculating balls) into housing. Align worm and rack piston. Turn stub shaft clockwise to engage worm. Maintain pressure on arbor until worm is fully engaged.

5) Rotate stub shaft clockwise to align middle rack groove in rack piston with center of sector shaft roller bearing. Remove arbor. Install a NEW side cover seal or gasket.

6) Thread side cover onto adjuster screw until bottomed. Back off 1/2 turn. Install sector shaft so center gear tooth meshes with center groove in rack piston. Install cover attaching bolts.

7) Install the adjuster lock nut halfway onto the sector shaft. Install piston and plug in rack piston. Install housing end cover "O" ring, end plug and retainer ring. Adjust the worm shaft thrust bearing preload and the sector shaft over-center preload. Refer to WORM SHAFT THRUST BEARING PRELOAD procedures under ADJUSTMENTS. Also refer to SECTOR SHAFT OVER-CENTER PRELOAD under ADJUSTMENTS.

## ADJUSTER PLUG OVERHAUL

### Disassembly

1) Using a screwdriver, carefully remove and discard thrust bearing retainer. Remove spacer, thrust bearing and bearing races. See Fig. 7. Remove and discard adjuster plug "O" ring.

2) Remove retaining ring. Remove and discard dust seal. Pry oil seal from adjuster plug, and discard seal. Inspect needle bearing. If necessary, press bearing from spacer end of adjuster plug.

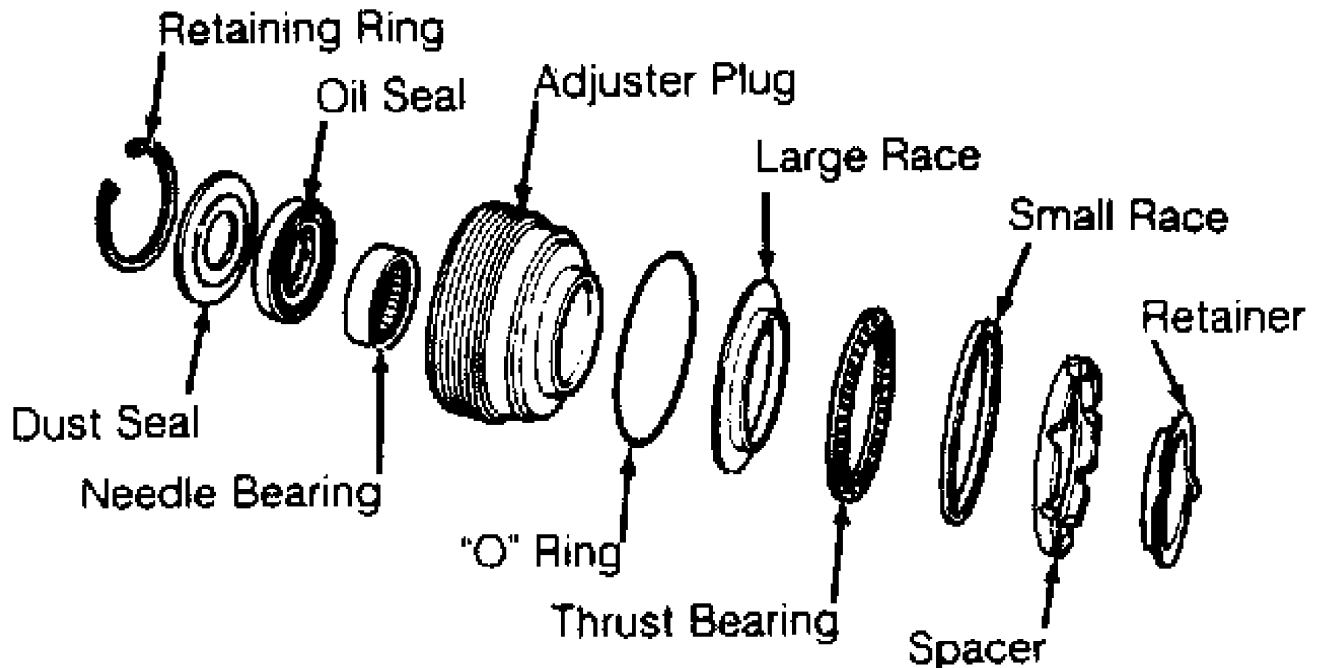


Fig. 7: Exploded View Of Adjuster Plug Assembly  
Courtesy of Chrysler Corp.

### Inspection

Inspect thrust bearing for cracks. Check rollers for pitting,

scoring and cracking. Check thrust races and spacer for damage. Replace parts as necessary.

#### Reassembly

1) Press needle bearing into adjuster plug (identification end facing arbor) until bearing bottoms in bore. Install oil seal with spring in seal facing adjuster plug. Install dust seal into adjuster plug.

2) Rubber face of dust seal must face away from plug. Install retaining ring and NEW adjuster plug "O" ring. Assemble thrust bearing, thrust bearing race and spacer on adjuster plug. Flanges of both thrust bearing races face away from plug. Install spacer. Using a punch, tap NEW retainer into position.

### RACK PISTON & WORM SHAFT ASSEMBLY OVERHAUL

#### Disassembly

Remove guide clamp, place complete unit on clean surface and remove ball guide. Remove arbor from rack piston. Remove and retain 24 recirculating balls. Remove Teflon piston rings and "O" ring seal.

#### Inspection

1) Clean and dry all parts. Inspect worm shaft and rack piston grooves for scoring. Inspect recirculating balls for damage. If any ball bearings are damaged, replace entire set. Check ball guides for pinched ends.

2) Inspect lower thrust bearing races for cracks, scores and pits. If either race is damaged, replace worm shaft and rack piston as an assembly. Inspect rack piston teeth for chips, cracks, dents and scores.

#### Reassembly

1) Lubricate NEW Teflon seal and "O" ring with power steering fluid, and carefully install onto rack piston. Install worm shaft into rack piston until worm shaft touches piston shoulder.

2) Turning worm shaft counterclockwise, insert recirculating balls into rack piston hole nearest piston ring. See Fig. 8. Install 18 recirculating balls in ball guide, beginning with a Black ball, and then alternating between Silver and Black. After installing each ball, press it down to provide space for next ball. Worm shaft will spiral outward as each ball is inserted.

3) Split ball guide halves, and fill one half with petroleum jelly. Install 6 remaining recirculating balls in ball guide half maintaining alternating pattern. Reassemble guide, and install in rack piston. Ensure end balls in guide are alternate of end balls in rack piston.

4) Install clamp, and tighten attaching bolts to 43 INCH lbs. (4.9 N.m). Insert Rack Piston Arbor (C-4175) into rack piston until it contacts worm shaft. Maintaining pressure on arbor, back worm shaft completely out of rack piston. DO NOT allow recirculating balls to drop out.

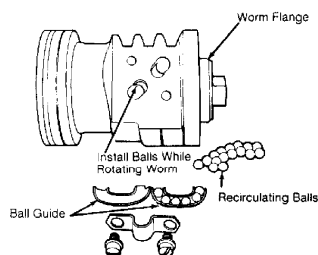


Fig. 8: Installing Recirculating Balls Into Rack Piston  
Courtesy of Chrysler Corp.

## VALVE BODY ASSEMBLY OVERHAUL

### Disassembly

1) Remove and discard stub shaft cap "O" ring. Lightly tap end of stub shaft against wood block until shaft cap is free of valve body. Pull stub shaft outward until drive pin hole is visible. See Fig. 9.

CAUTION: DO NOT pull shaft more than 1/4" (6 mm) to access pin or spool valve may cock in valve body.

2) Disengage drive pin. Remove stub shaft from valve body and spool valve assembly with a twisting motion. See Fig. 10. If binding occurs, realign valve.

CAUTION: DO NOT force stub shaft or spool valve from valve body.

3) Remove spool valve from valve body with twisting motion. Remove and discard all "O" and Teflon rings.

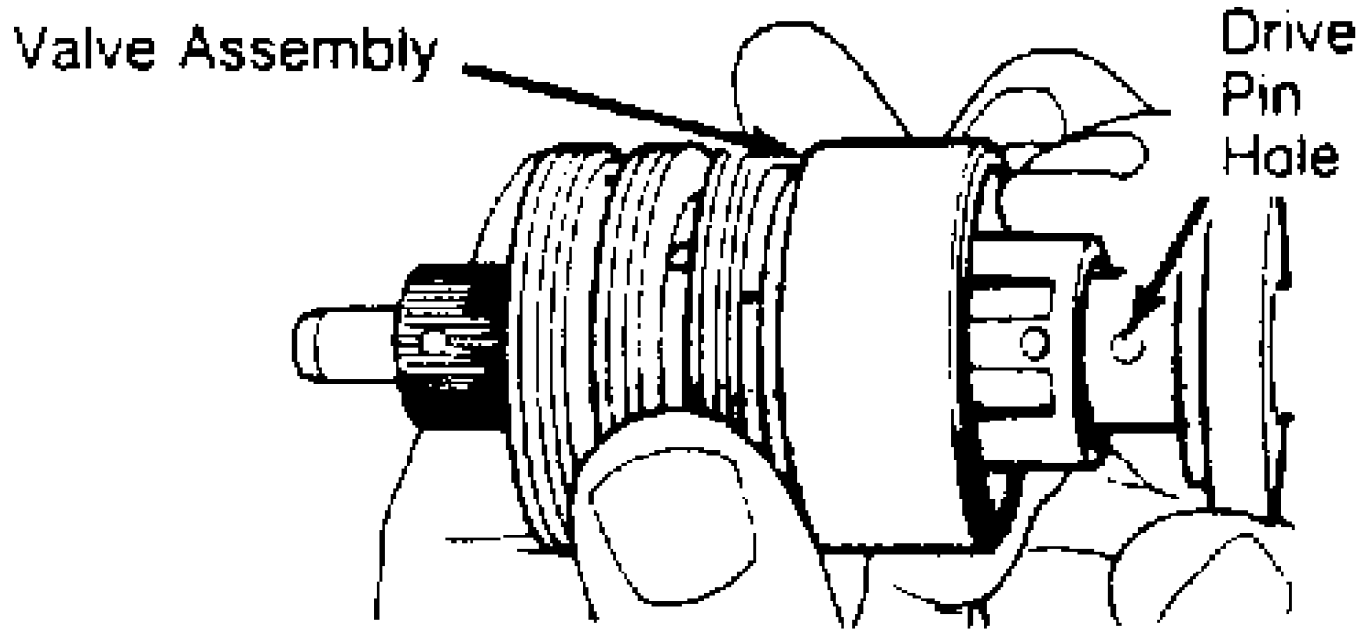
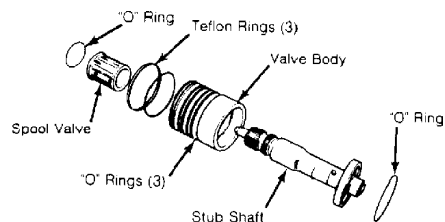


Fig. 9: Pulling Shaft From Valve Body  
Courtesy of Chrysler Corp.



30334  
Fig. 10: Exploded View Of Valve Body Assembly  
Courtesy of Chrysler Corp.

### Inspection

1) Wash all parts in solvent. Dry with compressed air. Check



for evidence of leaks between stub shaft and torsion bar. Check for nicks and scores on stub shaft. If possible, smooth stub shaft using crocus cloth. Check notch in valve body skirt for wear.

NOTE: Valve body is precision-built unit with selectively fitted and balanced components. If any component is faulty, entire assembly MUST be replaced.

2) Check spool valve fit in valve body with "O" ring removed. Lubricate spool valve with power steering fluid. Rotate spool valve in valve body. If valve does not rotate freely, replace complete valve assembly.

#### Reassembly

1) Lubricate valve body components with power steering fluid. Install NEW "O" rings in seal grooves. Carefully install NEW Teflon rings over "O" rings. DO NOT damage seal rings during installation.

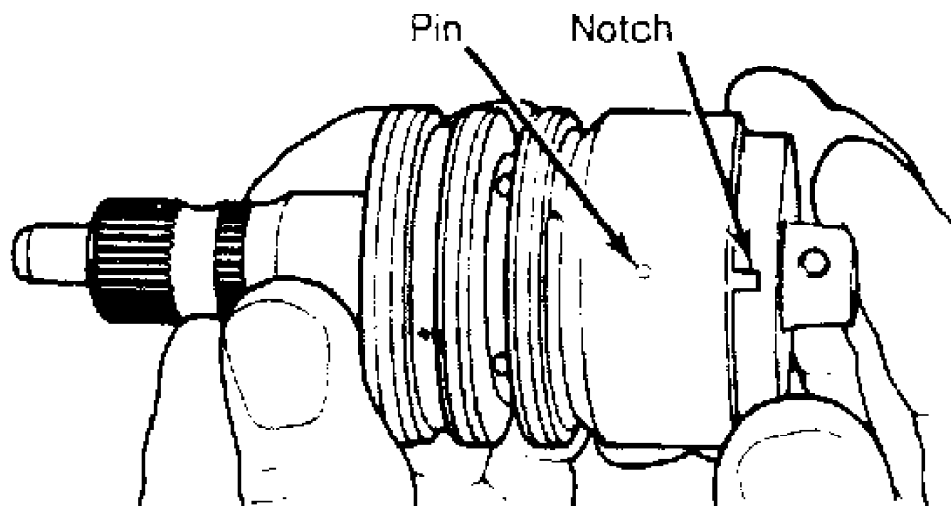
NOTE: Teflon seal rings may appear distorted after installation. However, heat of operation will straighten them.

2) Lubricate spool valve "O" ring with power steering fluid. Install on spool valve. Carefully insert spool valve into valve body.

3) Push spool valve through valve body until drive pin hole is visible at opposite end of valve body and spool valve is even with notched end of valve. Install stub shaft into spool valve and valve body. Install drive pin.

4) Align stub shaft drive pin with spool valve locating hole. Align notch in stub shaft cap with pin in valve body. Press stub shaft and spool valve into valve body. Install stub shaft cap "O" ring into valve body. See Fig. 6.

CAUTION: Before installing valve body into gear housing, ensure valve body stub shaft locating pin is fully engaged in stub shaft cap notch. DO NOT allow stub shaft to disengage from valve body pin. See Fig. 11.



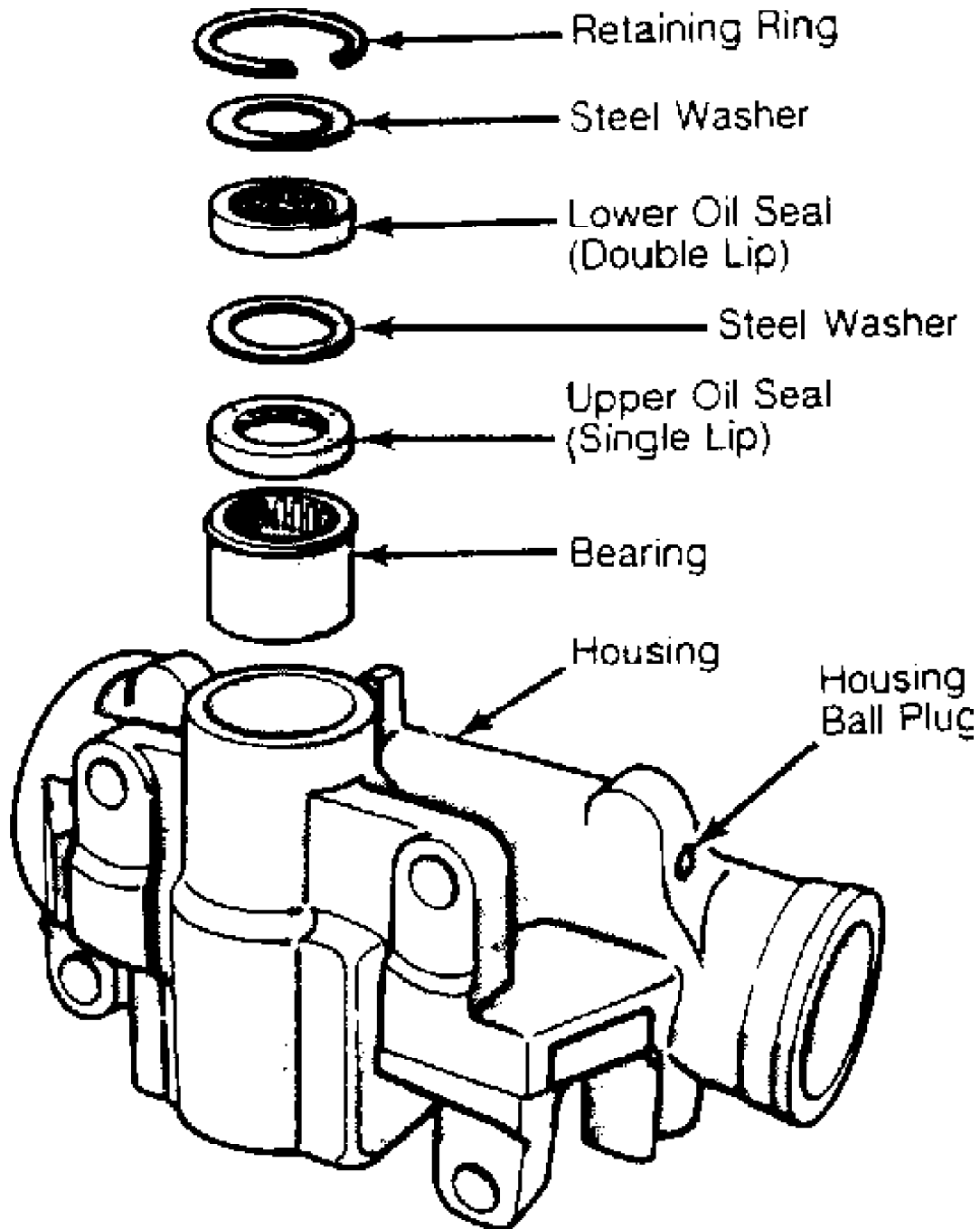
30336

Fig. 11: Aligning Pin & Notch For Stub Shaft  
Courtesy of Chrysler Corp.

#### HOUSING ASSEMBLY OVERHAUL

#### Disassembly

Remove sector shaft seal retaining ring. Remove steel washer. Remove lower oil seal, steel washer and upper oil seal from housing. See Fig. 12. Press sector shaft bearing out of housing from lower end.



30337

Fig. 12: Exploded View Of Gear Housing Seals & Bearing  
Courtesy of Chrysler Corp.

#### Inspection

1) If housing bore is severely worn, scored or pitted,

replace housing. Minor scratches may be removed using crocus cloth. Inspect housing ball plug for fluid leakage. Seat ball plug using blunt punch.

2) Inspect hose connector ports in steering gear housing for scores, cracks or damaged seats. If hose connector seat is damaged, steering gear housing must be replaced.

3) Spray ball area with Loctite Solvent (7559). Dry with compressed air. Cover ball area with Loctite Sealant (290). Allow sealant to cure 2 hours. Inspect all retaining ring, bearing and seal surfaces in housing. If any surface is worn or damaged, replace housing.

#### Reassembly

1) Install sector shaft bearing in steering housing using Handle (8015) and Adapter (7614). See Fig. 13. Position bearing so identification marks face away from adapter. Press in bearing until adapter bottoms against housing. DO NOT bottom bearing in housing.

2) Install lower oil seal, steel washer and upper oil seal on handle and adapter used to install bearing. See Fig. 14. Lips of both seals should face toward housing bore.

3) Install steel washer and retaining ring in housing. Using handle and adapter, drive in seals until retaining ring seats in groove. Ensure hose connector seat bores are clean.

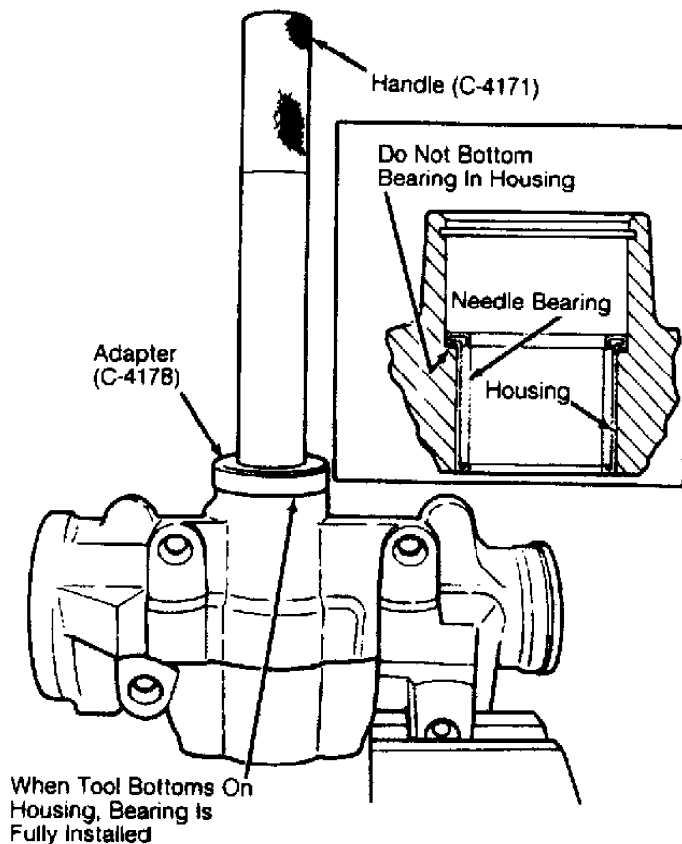


Fig. 13: Installing Sector Shaft Bearing  
Courtesy of Chrysler Corp.

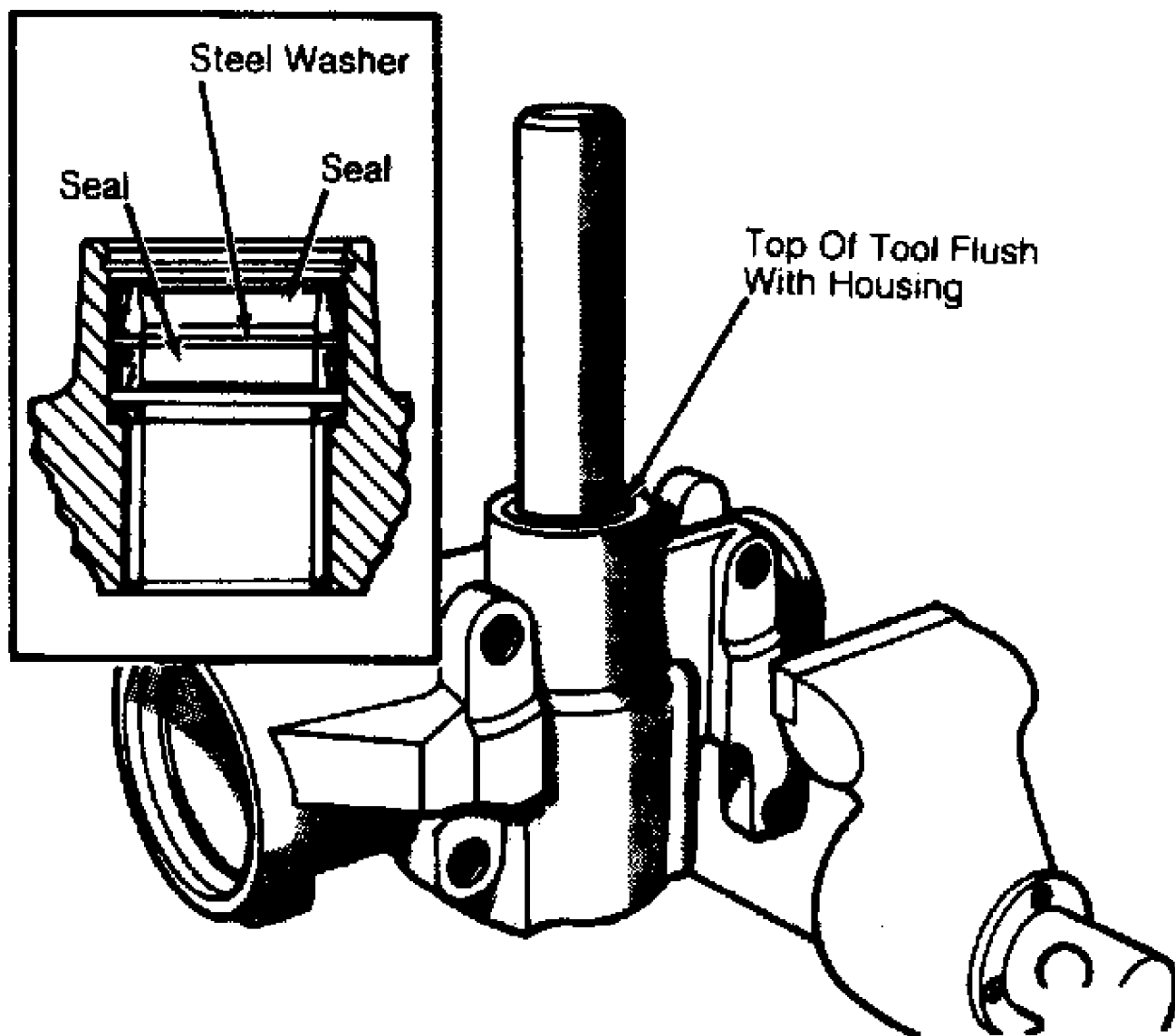


Fig. 14: Installing Sector Shaft Seals  
Courtesy of Chrysler Corp.

## WHEEL ALIGNMENT

After performing appropriate service procedures, refer to WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in the WHEEL ALIGNMENT section.

## TORQUE SPECIFICATIONS

### CHEROKEE

#### TORQUE SPECIFICATIONS (CHEROKEE)

Application	Ft. Lbs. (N.m)
Adjuster Plug Lock Nut .....	80 (108)

Drag Link Clamp Bolt .....	14 (19)
Drag Link-To-Pitman Arm Nut .....	60 (81)
Drag Link-To-Steering Knuckle Nut .....	35 (47)
Pitman Arm Attaching Nut .....	185 (251)
Pressure & Return Hose Fitting .....	21 (29)
Pump Bracket-To-Engine Bolt .....	33 (45)
Pump Pivot Bolt .....	20 (27)
Pump-To-Bracket Bolt .....	20 (27)
Rack Piston End Plug .....	50 (68)
Sector Shaft Adjuster Lock Nut .....	36 (49)
Side Cover Bolt .....	45 (61)
Steering Damper-To-Axle Bracket Bolt .....	55 (75)
Steering Damper-To-Drag Link Nut .....	35 (47)
Steering Gear-To-Frame Bolt .....	70 (95)
Tie Rod Clamp Bolt .....	22 (30)
Tie Rod End Stud Nut .....	35 (47)

## GRAND CHEROKEE & GRAND WAGONEER

### TORQUE SPECIFICATIONS (GRAND CHEROKEE & GRAND WAGONEER)

Application	Ft. Lbs. (N.m)
Adjuster Plug Lock Nut .....	80 (108)
Drag Link Clamp Bolt .....	30 (41)
Drag Link-To-Pitman Arm Nut .....	60 (81)
Pitman Arm Attaching Nut .....	185 (251)
Pressure & Return Hose Fitting .....	21 (29)
Pump Bracket-To-Engine Bolt .....	30 (41)
Pump Pivot Bolt .....	20 (27)
Pump-To-Bracket Bolt .....	20 (27)
Rack Piston End Plug .....	75 (102)
Sector Shaft Adjuster Lock Nut .....	36 (49)
Side Cover Bolt .....	45 (61)
Steering Damper-To-Axle Bracket Bolt .....	55 (75)
Steering Damper-To-Drag Link Nut .....	35 (47)
Steering Gear-To-Frame Bolt .....	(1) 65 (88)
Tie Rod Clamp Bolt .....	22 (30)
Tie Rod End Stud Nut .....	35 (47)

(1) - This specification has been revised as per  
TSB # 19-02-93 dated Feb. 22, 1993.

## WRANGLER

### TORQUE SPECIFICATIONS (WRANGLER)

Application	Ft. Lbs. (N.m)
Adjuster Plug Lock Nut .....	80 (108)
Drag Link Clamp Bolt .....	36 (49)
Drag Link-To-Pitman Arm Nut .....	60 (81)
Drag Link-To-Tie Rod Nut .....	35 (47)
Pitman Arm Attaching Nut .....	185 (251)
Pressure & Return Hose Fitting .....	21 (29)
Pump Bracket-To-Engine Bolt .....	33 (45)
Pump Pivot Bolt .....	20 (27)
Pump-To-Bracket Bolt .....	20 (27)
Rack Piston End Plug .....	50 (68)
Sector Shaft Adjuster Lock Nut .....	36 (49)
Side Cover Bolt .....	45 (61)

Steering Damper-To-Axle Bracket Bolt .....	55	(75)
Steering Damper-To-Drag Link Nut .....	35	(47)
Steering Damper-To-Tie Rod Nut .....	53	(72)
Steering Gear-To-Frame Bolt .....	75	(102)
Tie Rod Clamp Bolt .....	25	(34)
Tie Rod End Stud Nut .....	35	(47)

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# **\* STEERING UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

Steering, Suspension, Wheel Alignment, Wheels and Tires  
Motorist Assurance Program  
Standards For Automotive Repair

All Makes and Models

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

### **CONTENTS**

Motorist Assurance Program (MAP)

#### OVERVIEW

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

Steering and Suspension

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AIR RIDE SUSPENSION - AIR SHOCKS AND AIR STRUTS

AIR RIDE SUSPENSION - AIR SPRING VALVES

AIR RIDE SUSPENSION - AIR SPRINGS

AIR RIDE SUSPENSION - COMPRESSORS

AIR RIDE SUSPENSION - HEIGHT SENSORS

AIR RIDE SUSPENSION - MODULES

AIR RIDE SUSPENSION - RELAYS (COMPRESSOR)

AIR RIDE SUSPENSION - SWITCHES (ON/OFF)

AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)

AIR RIDE SUSPENSION - TUBING

AIR RIDE SUSPENSION - WARNING LAMPS

AIR RIDE SUSPENSION - WIRING HARNESES

BALL JOINTS

BUSHINGS

CENTER LINKS

CONTROL ARM SHAFTS

CONTROL ARMS

DRAG LINKS

ELECTRONIC RIDE CONTROL SHOCKS AND STRUTS

IDLER ARMS

KING PINS

PITMAN ARMS

POWER STEERING HOSES

POWER STEERING (HYDRAULIC) PUMPS

RADIUS ARMS

RELAY RODS

SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES

SPINDLES

SPRINGS - COIL, LEAF AND TORSION BAR

STEEL POWER STEERING LINES

STEERING ARMS

STEERING DAMPERS

STEERING GEARS (EXCEPT RACK AND PINION)

STEERING GEARS - RACK AND PINION

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SWAY BAR LINKS

SWAY BARS

TIE ROD ENDS (INNER AND OUTER)  
TRACK BARS  
TRAILING ARMS  
WHEEL BEARINGS, RACES AND SEALS

Wheel Alignment

WHEEL ALIGNMENT

Wheels and Tires

TIRES  
VALVE STEMS  
WHEEL ATTACHMENT HARDWARE  
WHEELS (RIMS)

## **MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles—through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt 1) a Pledge of Assurance to their Customers and 2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-



profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

1444 I Street, NW Suite 700  
Washington, DC 20005  
Phone (202) 712-9042 Fax (202) 216-9646  
January 1999

## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

#### **Example:**

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

#### **Example:**

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present

the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

## STEERING AND SUSPENSION

### SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

Steering and suspension are complex systems made up of a variety of interdependent components. For proper vehicle handling, ride, and tire wear, a thorough inspection is required whenever suspension work is being performed.

Conditions listed assume that the problem has been isolated to the specific component by proper testing procedures.

**NOTE:** When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

**CAUTION:** DO NOT use ride height altering or load compensating components, such as variable rate springs and coil over shocks, on vehicles with height or load sensing proportioning valve-equipped braking systems, unless these components are original equipment.

## AIR RIDE SUSPENSION

**NOTE:** Depending on the air suspension design, there are some aftermarket products available to eliminate the air ride suspension on certain vehicles. If the system has been eliminated with one of these products, then no service is suggested or required.

### AIR RIDE SUSPENSION - AIR SHOCKS AND AIR STRUTS

**NOTE:** This section covers the air spring portion of the air shock or strut. For damping portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

#### AIR RIDE SUSPENSION - AIR SHOCK AND AIR STRUT INSPECTION

Condition	Code	Procedure
Inner fabric of air bag damaged .....	A .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible .....	1 .....	Suggest replacement.

## AIR RIDE SUSPENSION - AIR SPRING VALVES

#### AIR RIDE SUSPENSION - AIR SPRING VALVE INSPECTION

Condition	Code	Procedure
-----------	------	-----------

Attaching hardware incorrect .....	A	.....	Require replacement of incorrect part.
Attaching hardware loose .....	A	...	Require repair or replacement of loose part.
Attaching hardware missing .....	C	..	Require replacement of missing part.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Blocked .....	A	..	Require repair or replacement.
Connector bent .....	A	..	Require repair or replacement.
Connector broken .....	A	.....	Require replacement.
Connector loose .....	A	..	Require repair or replacement.
Inoperative .....	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Restricted .....	A	..	Require repair or replacement.

## AIR RIDE SUSPENSION - AIR SPRINGS

### AIR RIDE SUSPENSION – AIR SPRING INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Collar cracked .....	A	..... Require replacement.
End cap cracked .....	A	..... Require replacement.
Inner fabric of bag damaged .....	A	..... Require replacement.
Leaking .....	A	.. Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible .....	1	..... Suggest replacement.
Piston cracked .....	A	..... Require replacement.

## AIR RIDE SUSPENSION - COMPRESSORS

### AIR RIDE SUSPENSION - COMPRESSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Connector bent .....	A ..	Require repair or replacement.
Connector broken .....	A .....	Require replacement.
Connector loose .....	A ..	Require repair or replacement.
Does not build pressure .	A .....	(1) Further inspection required.
Excessive run time .....	B .....	(2) Further inspection required.
Inoperative .....	A .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.

(1) - If failure to build pressure is traced to the compressor, require replacement.

(2) - If excessive run time is traced to the compressor, require replacement.

## AIR RIDE SUSPENSION - HEIGHT SENSORS

### AIR RIDE SUSPENSION - HEIGHT SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity ....	A .....	Require replacement of corroded part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware		

threads damaged .....	A	...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Dust boot missing .....	2	.....	(1) Suggest replacement.
Dust boot split .....	2	.....	(1) Suggest replacement.
Dust boot torn .....	2	.....	(1) Suggest replacement.
Housing cracked .....	A	.....	Require replacement.
Lead routing incorrect ..	B	..	Require rerouting according to vehicle manufacturer's specifications.
Loose .....	B	...	Require adjustment to vehicle manufacturer's specifications.
Missing .....	C	.....	Require replacement.
Output signal incorrect .	A	..	Require repair or replacement.
Wire lead damaged .....	A	..	Require repair or replacement.

(1) - This condition can lead to damage of the sliding magnet, which, in turn, causes premature sensor failure.

## AIR RIDE SUSPENSION - MODULES

### AIR RIDE SUSPENSION - MODULE INSPECTION

Condition	Code	Procedure
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Housing cracked .....	2	.. Suggest repair or replacement.
Inoperative .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.

## AIR RIDE SUSPENSION - RELAYS (COMPRESSOR)

### AIR RIDE SUSPENSION - RELAY (COMPRESSOR) INSPECTION

Condition	Code	Procedure
Housing cracked .....	2	..... (1) Suggest replacement.
Intermittent .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Output signal incorrect .	A	..... Require replacement.

(1) - If moisture enters the relay, it can reduce life expectancy or impair function.

## AIR RIDE SUSPENSION - SWITCHES (ON/OFF)

#### AIR RIDE SUSPENSION - SWITCH (ON/OFF) INSPECTION

Condition	Code	Procedure
Broken .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Output signal incorrect .	A .....	Require replacement.

#### AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)

##### AIR RIDE SUSPENSION - TORSION SPRING (COUNTER BALANCING) INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Broken .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.

#### AIR RIDE SUSPENSION - TUBING

##### AIR RIDE SUSPENSION - TUBING INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Blocked .....	A ..	Require repair or replacement.
Fitting incorrect .....	B .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Line type incorrect .....	B .....	Require replacement.
Missing .....	C .....	Require replacement.
Restricted .....	A ..	Require repair or replacement.
Routed incorrectly .....	B .....	Require routing correction.

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## AIR RIDE SUSPENSION - WARNING LAMPS

### AIR RIDE SUSPENSION - WARNING LAMP INSPECTION

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Condition	Code	Procedure
Bulb burned out .....	A .....	Require replacement.
Warning light does not come on during bulb check .....	.. .	Further inspection required to determine cause.
Warning light flashes ...	.. .	Further inspection required to determine cause.
Warning light is intermittent .....	.. .	Further inspection required to determine cause.
Warning light stays on after initial bulb check .....	.. .	Further inspection required to determine cause.

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## AIR RIDE SUSPENSION - WIRING HARNESSSES

### AIR RIDE SUSPENSION - WIRING HARNESS INSPECTION

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Condition	Code	Procedure
Connector bent .....	A ..	Require repair or replacement.
Connector broken .....	A ..	Require repair or replacement.
Connector loose .....	A ..	Require repair or replacement.
Damaged (cut, burned, or chafed) .....	A ..	Require repair or replacement.
Excessive resistance ....	B ..	Require repair or replacement.
Fuse blown .....	A .....	Require replacement.
Fusible link blown .....	A .....	Require replacement.
Open .....	A ..	Require repair or replacement.
Poor ground .....	A ..	Require repair or replacement.
Routed incorrectly .....	B ..	Require rerouting according to vehicle manufacturer's specifications.
Shorted .....	A ..	Require repair or replacement.
Terminal bent .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal corroded .....	A ..	Require repair or replacement.
Terminal loose .....	A ..	Require repair or replacement.

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## BALL JOINTS

Before requiring or suggesting ball joint replacement, the approved OEM procedure must be used to measure ball joint wear. The measurement(s) obtained, along with the vehicle manufacturer's specifications, must be noted on the inspection report. Some states require that these measurements also appear on the invoice.

**NOTE:** The term "perceptible movement," defined as any visible movement in any direction, has been the industry standard for determining the need for replacement of follower ball joints. Some vehicle manufacturers are now publishing specifications for follower ball joints that were



previously diagnosed by the "perceptible movement" standard. Before requiring or suggesting any parts be replaced based on "perceptible movement," consult your repair manual to determine if OEM specifications exist.

You are not required to replace ball joints in axle sets. However, when replacing a ball joint due to wear exceeding manufacturer's specification, you may suggest replacement of the other ball joint if its measurement shows it is close to the end of its useful life, for preventive maintenance.

#### BALL JOINT INSPECTION

Condition	Code	Procedure
Attaching hardware bent	. B ...	Require repair or replacement of bent part if available; otherwise, replace ball joint.
Attaching hardware broken .....	A ...	Require replacement of broken part if available; otherwise, replace ball joint.
Attaching hardware corroded, affecting structural integrity ...	A .	Require replacement of corroded part if available; otherwise, replace ball joint.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part if available; otherwise, replace ball joint.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part if available; otherwise, replace ball joint.
Attaching hardware missing .....	C ..	Require replacement of missing part if available; otherwise, replace ball joint.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads if available; otherwise, replace ball joint.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads if available; otherwise, replace ball joint.
Binding .....	A .....	(1) Further inspection required.
Grease boot cracked .....	2 .....	(2) Suggest replacement.
Grease boot missing .....	2 .....	(3) Suggest replacement.
Grease boot torn .....	2 .....	(4) Suggest replacement.
Grease fitting broken ...	A ...	Require replacement of grease fitting.
Grease fitting missing ..	C ...	Require replacement of grease fitting.
Grease fitting won't seal .....	A ...	Require replacement of grease fitting.
Greaseable ball joint will		

not take grease .....	2	.....	(5) Suggest replacement of grease fitting.
Nut on ball joint loose .	A	.....	(6) Require repair or replacement.
Pre-load adjustment incorrect .....	B	..	Require repair or replacement.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(7) Require replacement.
Stud broken .....	A	.....	(7) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(7) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - If greaseable, grease ball joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the ball joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the ball joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the ball joint and will accelerate wear.
- (5) - If the greaseable ball joint still will not take grease after replacing the grease fitting, suggest replacement of ball joint.
- (6) - Check for bent stud or damaged taper hole.
- (7) - Check for damaged taper hole.

## BUSHINGS

### BUSHING INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B	... Require repair or replacement of bent part if available; otherwise, replace bushing.
Attaching hardware broken .....	A	... Require replacement of broken part if available; otherwise, replace bushing.
Attaching hardware corroded, affecting structural integrity ...	A	. Require replacement of corroded part if available; otherwise, replace bushing.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part if available; otherwise, replace bushing.
Attaching hardware loose .....	A	... Require repair or replacement of loose part if available; otherwise, replace bushing.
Attaching hardware missing .....	C	.. Require replacement of missing part if available; otherwise, replace bushing.
Attaching hardware threads damaged .....	A	... Require repair or replacement

of part with damaged threads if  
available; otherwise, replace  
bushing.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads if available; otherwise, replace bushing.
Binding .....	A	..	Require repair or replacement.
Deteriorated, affecting performance .....	A	..	Require repair or replacement.
Distorted, affecting performance .....	A	..	Require repair or replacement.
Leaking (fluid-filled type) .....	A	.....	Require replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	.....	(1) Further inspection required.
Rubber separating from internal metal sleeve on bonded bushing .....	A	.....	Require replacement.
Seized .....	A	.....	Require replacement.
Shifted (out of position) .....	B	..	Require repair or replacement.
Split .....	A	.....	Require replacement.
Surface cracking (weather- checked) .....	..	.....	No service suggested or required.

(1) - If noise isolated to bushing, suggest repair or  
replacement.

CAUTION: Use only approved lubricant on rubber bushings.  
Petroleum-based lubricants may damage rubber bushings.

## CENTER LINKS

### CENTER LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace center link.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace center link.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace center link.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace center link.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if

			available; otherwise, replace center link.
Bent .....	B .....		Require replacement.
Binding .....	A .....	(1)	Further inspection required.
Grease boot cracked .....	2 .....	(2)	Suggest replacement.
Grease boot missing .....	2 .....	(3)	Suggest replacement.
Grease boot torn .....	2 .....	(4)	Suggest replacement.
Grease fitting broken ...	A ...		Require replacement of grease fitting.
Grease fitting missing ..	C ...		Require replacement of grease fitting.
Grease fitting won't seal .....	A ...		Require replacement of grease fitting.
Grease seal missing .....	2 .....	(3)	Suggest replacement.
Grease seal torn .....	2 .....	(4)	Suggest replacement.
Looseness (perceptible horizontal movement) ...	1 .....	(5)	Suggest replacement.
Looseness that is excessive .....	B .....	(5) (6)	Require replacement.
Seized .....	A .....		Require replacement.
Stud bent .....	B .....	(7)	Require replacement.
Stud broken .....	A .....	(7)	Require replacement.
Stud loose in taper hole .....	A .....	(7)	Require repair or replacement.
Taper hole elongated ....	A .....	(8)	Require replacement.
Threads damaged .....	A ..		Require repair or replacement.
Threads stripped (threads missing) .....	A .....	(7)	Require replacement.
Wear exceeds manufacturer's specifications .....	B .....		Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (7) - Check for damaged taper hole.
- (8) - Check for damaged stud.

## CONTROL ARM SHAFTS

### CONTROL ARM SHAFT INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require replacement of broken

				part, if available; otherwise, replace shaft.
Attaching hardware loose .....	A	...	Require repair or replacement of loose part, if available; otherwise, replace shaft.	
Attaching hardware missing .....	C	..	Require replacement of missing part, if available; otherwise, replace shaft.	
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace shaft.	
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace shaft.	
Bent .....	B	.....	Require replacement.	
Shaft bushing surface undersized (worn) .....	B	.....	Require replacement.	
Threads damaged .....	A	..	Require repair or replacement.	
Threads stripped (threads missing) .....	A	.....	Require replacement.	

## CONTROL ARMS

### CONTROL ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B	... Require repair or replacement of bent part, if available; otherwise, replace control arm.
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace control arm.
Attaching hardware corroded, affecting structural integrity ...	A	. Require replacement of corroded part, if available; otherwise, replace control arm.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace control arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace control arm.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace control arm.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads,

if available; otherwise,  
replace control arm.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace control arm.
Bent .....	B	.....	Require replacement.
Bushing hole oversized ..	B	.....	Require replacement.
Ball joint hole oversized (loose interference or press fit) .....	B	.....	(1) Further inspection required.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - If oversized ball joint is available, require  
replacement of ball joint. If oversized ball joint  
is not available, require replacement of control arm.

## DRAG LINKS

### DRAG LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace drag link.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace drag link.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace drag link.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace drag link.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace drag link.
Bent .....	B	..... Require replacement.
Binding .....	A	..... (1) Further inspection required.
Grease boot cracked .....	2	..... (2) Suggest replacement.
Grease boot missing .....	2	..... (3) Suggest replacement.
Grease boot torn .....	2	..... (4) Suggest replacement.
Grease fitting broken ...	A	... Require replacement of grease fitting.

Grease fitting missing ..	C	...	Require replacement of grease fitting.
Grease fitting won't seal .....	A	...	Require replacement of grease fitting.
Grease seal missing .....	2	.....	(5) Suggest replacement.
Grease seal torn .....	2	.....	(4) Suggest replacement.
Looseness (perceptible horizontal movement) ...	1	.....	(6) Suggest replacement.
Looseness that is excessive .....	B	.....	(6) (7) Require replacement.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(8) Require replacement.
Stud broken .....	A	.....	(8) Require replacement.
Stud loose in taper hole .....	A	.....	(8) Require repair or replacement.
Taper hole elongated ....	A	.....	(9) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(8) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - Missing grease seal will allow contaminants to enter the joint and will accelerate wear.
- (6) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (7) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (8) - Check for damaged taper hole.
- (9) - Check for damaged stud.

## ELECTRONIC RIDE CONTROL SHOCKS AND STRUTS

NOTE: This section covers the electronic damping control portion of the electronic shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

### ELECTRONIC RIDE CONTROL SHOCK AND STRUT INSPECTION

Condition	Code	Procedure
Connector bent .....	A ..	Require repair or replacement.
Connector broken .....	A ..	Require repair or replacement.
Connector loose .....	A ..	Require repair or replacement.
Electronic valve control		

inoperative .....	2	.....	(1) Suggest replacement.
Terminal bent .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal corroded .....	A	..	Require repair or replacement.
Terminal loose .....	A	..	Require repair or replacement.

(1) - It is acceptable to replace with a non-electronically controlled unit, where available.

## IDLER ARMS

### IDLER ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace idler arm.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace idler arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace idler arm.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace idler arm.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace idler arm.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace idler arm.
Binding .....	A	..... (1) Further inspection required.
Grease boot cracked .....	2	..... (2) Suggest replacement.
Grease boot missing .....	2	..... (3) Suggest replacement.
Grease boot torn .....	2	..... (4) Suggest replacement.
Grease fitting broken ...	A	... Require replacement of grease fitting.
Grease fitting missing ..	C	... Require replacement of grease fitting.
Grease fitting won't seal .....	A	... Require replacement of grease fitting.
Grease seal missing .....	2	..... (5) Suggest replacement.
Grease seal torn .....	2	..... (4) Suggest replacement.
Greaseable joint will not take grease .....	2	..... (1) Suggest replacement of grease fitting.
Looseness at frame bracket end .....	B	..... (6) (7) Require repair or replacement.



Looseness at link end (perceptible horizontal movement) .....	1	.....	(8) Suggest replacement.
Looseness at link end that is excessive .....	B	.....	(8) (9) Require replacement.
Mounted out of position (center link not parallel) .....	B	.....	Require repositioning.
Nut on stud loose .....	A	.....	(10) Require repair or replacement.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(11) Require replacement.
Stud broken .....	A	.....	(11) Require replacement.
Taper hole elongated ....	A	.....	(12) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(11) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (5) - Missing grease seal will allow contaminants to enter joint and will accelerate wear.
- (6) - If manufacturer's procedures and specifications exist, use those procedures and specifications; otherwise, use an approved inspection method such as the dry park check.
- (7) - Looseness is defined as movement that creates excessive toe change.
- (8) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

- CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
- (9) - Excessive looseness is defined as significant enough to affect vehicle handling or structural integrity.
  - (10) - Check for bent stud or damaged taper hole.
  - (11) - Check for damaged taper hole.
  - (12) - Check for damaged stud.

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## KING PINS

You are not required to replace king pins in axle sets. However, when replacing a king pin due to wear exceeding manufacturer's specifications, you may suggest replacement of the other king pin on the axle if its measurement shows it is close to the end of its useful life.

### KING PIN INSPECTION

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Condition	Code	Procedure
Bearing balls pitted ....	A	..... Require replacement.
Bearing balls worn .....	A	..... Require replacement.
Bearing races pitted ....	A	..... Require replacement.

Bearing races worn .....	A	.....	Require replacement.
Bearing rollers pitted ..	A	.....	Require replacement.
Bearing rollers worn ....	A	.....	Require replacement.
Bearing seal bent .....	2	.	Suggest replacement of seal or bearing.
Bearing seal missing ....	2	.	Suggest replacement of seal or bearing.
Bearing seal torn .....	2	.	Suggest replacement of seal or bearing.
Binding .....	A	..	Require repair or replacement of affected parts.
End caps missing .....	C	.	Require replacement of missing part, if available; otherwise, replace king pin.
End play exceeds specifications .....	B	.....	Require repair.
Grease fitting broken ...	A	..	Require replacement of grease fitting.
Grease fitting missing ..	C	..	Require replacement of grease fitting.
Grease fitting won't seal .....	A	..	Require replacement of grease fitting.
Locating pins missing ...	C	.	Require replacement of missing part, if available; otherwise, replace king pin.
Looseness exceeds manufacturer's specifications .....	B	....	Require replacement of worn parts.
Seized .....	A	.....	Require replacement.
Threads damaged .....	A	.	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Will not take grease ....	2	.....	(1) Suggest replacement of grease fitting.

(1) - If king pin will not take grease after replacement of grease fitting, suggest replacement of king pin.

## PITMAN ARMS

### PITMAN ARM INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace pitman arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace pitman arm.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace pitman arm.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise,

replace pitman arm.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace pitman arm.
Bent .....	B	.....	Require replacement.
Binding .....	A	.....	(1) Further inspection required.
Grease boot cracked .....	2	.....	(2) Suggest replacement.
Grease boot missing .....	2	.....	(3) Suggest replacement.
Grease boot torn .....	2	.....	(4) Suggest replacement.
Grease fitting broken ...	A	.....	Require replacement grease fitting.
Grease fitting missing ..	C	...	Require replacement of grease fitting.
Grease fitting won't seal .....	A	...	Require replacement of grease fitting.
Grease seal missing .....	2	.....	(3) Suggest replacement of seal.
Grease seal torn .....	2	.....	(4) Suggest replacement of seal.
Looseness (perceptible horizontal movement) ...	1	.....	(5) Suggest replacement.
Looseness that is excessive .....	B	.....	(5) (6) Require replacement.
Nut on stud loose .....	A	.....	(7) Require repair or replacement.
Seized .....	A	.....	Require replacement.
Splines damaged .....	A	..	Require repair or replacement.
Splines stripped (splines missing) .....	A	.....	Require replacement.
Stud bent .....	B	.....	(8) Require replacement.
Stud broken .....	A	.....	(8) Require replacement.
Stud loose in taper hole .....	A	.....	(8) Require repair or replacement.
Taper hole elongated ....	A	.....	(9) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(8) Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
  - (7) - Check for bent stud of damaged taper hole.
  - (8) - Check for damaged taper hole.
  - (9) - Check for damaged stud.
-

## POWER STEERING HOSES

### POWER STEERING HOSE INSPECTION

Condition	Code	Procedure
Blistered .....	B	..... Require replacement.
Blocked .....	A	. Require repair or replacement.
Fitting threads damaged .	A	. Require repair or replacement.
Fitting threads stripped (threads missing) .....	A	..... Require replacement.
Inner fabric (webbing) cut .....	A	..... Require replacement.
Leaking .....	A	. Require repair or replacement.
Missing .....	C	..... Require replacement.
Outer covering is cracked to the extent that the inner fabric of hose is visible .....	B	..... Require replacement.
Restricted .....	A	. Require repair or replacement.

## POWER STEERING (HYDRAULIC) PUMPS

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

### POWER STEERING (HYDRAULIC) PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B	... Require repair or replacement of bent part.
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Belt alignment incorrect .....	B	..... (1) Further inspection required.
Belt cracked .....	1	..... Suggest replacement.
Belt frayed .....	1	..... Suggest replacement.
Belt missing .....	C	..... Require replacement.
Belt noisy .....	2	..... (2) Further inspection required.
Belt plies separated ....	A	..... Require replacement.

Belt tension out of specification .....	B	.....	Require adjustment or replacement.
Belt worn beyond adjustment range .....	B	.....	Require replacement.
Belt worn so it contacts bottom of pulley .....	A	.....	Require replacement.
Binding .....	A	..	Require repair or replacement.
Fluid at or beyond service interval .....	3	.....	Suggest fluid change.
Fluid contaminated .....	B	.....	(3) Require flushing and refilling of the system.
Fluid level incorrect ...	B	.....	Require adjustment of fluid level.
Inadequate assist .....	A	.....	(4) Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Noise .....	2	.....	(5) Further inspection required.
Pulley bent .....	A	...	Require repair or replacement of pulley.
Pulley missing .....	C	..	Require replacement of pulley.
Remote reservoir leaking .....	A	.....	Require replacement of reservoir,
Reservoir cap broken ....	A	.....	Require replacement of cap.
Reservoir cap missing ...	C	.....	Require replacement of cap.
Seized .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

- (1) - Determine cause of incorrect alignment and require repair.  
(2) - Determine cause of noise and suggest repair.  
(3) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.  
(4) - If pump is source of inadequate assist, require repair or replacement.  
(5) - If noise is isolated to pump, suggest repair or replacement.

## RADIUS ARMS

### RADIUS ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Bent .....	B	.....	Require replacement.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

## RELAY RODS

### RELAY ROD INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace relay rod.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace relay rod.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace relay rod.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace relay rod.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace relay rod.
Bent .....	B	..... Require replacement.
Binding .....	A	..... (1) Further inspection required.
Grease boot cracked .....	2	..... (2) Suggest replacement.
Grease boot missing .....	2	..... (3) Suggest replacement.
Grease boot torn .....	2	..... (4) Suggest replacement.
Grease fitting broken ...	A	..... Require replacement grease fitting.
Grease fitting missing ..	C	... Require replacement of grease fitting.
Grease fitting won't seal .....	A	... Require replacement of grease fitting.
Grease seal missing .....	2	..... (3) Suggest replacement.
Grease seal torn .....	2	..... (4) Suggest replacement.
Looseness (perceptible horizontal movement) ...	1	..... (5) Suggest replacement.
Looseness that is excessive .....	B	..... (5) (6) Require replacement.
Seized .....	A	..... Require replacement.
Stud bent .....	B	..... (7) Require replacement.

Stud loose in taper hole .....	A .....	(7) Require repair or replacement.
Taper hole elongated ....	A .....	(8) Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	(7) Require replacement.
Wear exceeds manufacturer's specifications .....	B .....	Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (7) - Check for damaged taper hole.
- (8) - Check for damaged stud.

## SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES

You are not required to replace shocks or struts in axle sets. However, when replacing a shock or strut due to the conditions that follow, you may suggest replacement of the other shock or strut on the same axle for improved performance and preventive maintenance.

- \* Part is close to the end of its useful life
- \* To extend tire life
- \* To balance ride and handling
- \* To improve stopping distance

When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

Under no circumstances should a technician bend struts or strut housings.

A vehicle's load-carrying and handling abilities are limited by its suspension, tires, brakes, and driveline. Installing coil over shocks or any other load assist device does not increase the vehicle's load capacity. See the vehicle owner's manual for more details.

NOTE: If vehicle is equipped with original equipment coil over shocks, apply the conditions for coil springs from the SPRINGS - COIL, LEAF AND TORSION BAR section of the STEERING AND SUSPENSION guidelines. If the vehicle is equipped with add-on coil over shocks, you may suggest replacing the shocks with standard shocks for any spring-related condition.

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## SHOCK ABSORBER, STRUT CARTRIDGE AND STRUT ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part, if available; otherwise, replace shock or strut.
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise, replace shock or strut.
Attaching hardware corroded, affecting structural integrity ...	A .	Require replacement of corroded part, if available; otherwise, replace shock or strut.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part, if available; otherwise, replace shock or strut.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace shock or strut.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace shock or strut.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads, if available; otherwise, replace shock or strut.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads, if available; otherwise, replace shock or strut.
Binding .....	A .....	Require replacement.
Body dented .....	A .....	(1) Further inspection required.
Body punctured .....	A .....	Require replacement.
Brake hose bracket bent .....	B ..	Require repair or replacement.
Brake hose bracket missing .....	C .....	Require replacement.
Brake hose bracket threads damaged .....	A ..	Require repair or replacement.
Brake hose bracket threads stripped (threads missing) .....	C .....	Require replacement.
Compression bumper missing .....	C .....	Require replacement of compression bumper.
Compression bumper split .....	1 .....	Suggest replacement of compression bumper.
Damping (none) .....	A .....	Require replacement.
Dust boot (bellows) split .....	2 .....	(2) Suggest replacement of boot.



Dust boot (bellows) missing .....	2	..... (2) Suggest replacement of boot.
Dust boot (bellows) torn .....	2	..... (2) Suggest replacement of boot.
Dust shield broken .....	2	..... (2) Suggest replacement.
Dust shield missing .....	2	..... (2) Suggest replacement.
Gland nut (strut housing cap) is not removable using appropriate tool .	A	.. (3) Require replacement of nut and/or housing.
Gland nut (strut housing cap) threads damaged ...	A	... Require repair or replacement of nut.
Gland nut (strut housing cap) threads stripped (threads missing) .....	A	..... Require replacement of nut.
Housing dented .....	A	..... (1) Further inspection required.
Housing punctured .....	A	..... Require replacement.
Jounce bumper missing ...	C	... Require replacement of jounce bumper.
Jounce bumper split .....	1	... Suggest replacement of jounce bumper.
Leaking oil, enough for fluid to be running down the body .....	A	..... (4) Require replacement.
Noise .....	2	..... (5) Further inspection required.
Piston rod bent .....	A	..... Require replacement.
Piston rod broken .....	A	..... Require replacement.
Piston rod has surface defect .....	2	..... Suggest replacement.
Piston rod threads damaged .....	A	.. Require repair or replacement.
Piston rod threads stripped (threads missing) .....	A	..... Require replacement.
Seized .....	A	..... Require replacement.
Shock missing .....	C	..... Require replacement.
Strut housing bent .....	A	..... Require replacement.
Strut housing cap (gland nut) is not removable using appropriate tool .	A	..... (3) Require replacement of nut and/or housing.
Strut housing cap (gland nut) threads damaged ...	A	... Require repair or replacement of nut.
Strut housing cap (gland nut) threads stripped (threads missing) .....	A	..... Require replacement of nut.
Strut housing severely corroded, affecting structural integrity ...	A	..... Require replacement.
Strut housing threads damaged .....	A	.. Require repair or replacement.
Strut housing threads stripped (threads missing) .....	A	..... Require replacement.
Tire cupping .....	A	..... (6) Further inspection required.

- (1) - Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.
- (2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
- (3) - Only required if replacing cartridge.
- (4) - CAUTION: If the strut cartridge has been replaced previously, the oil on the strut housing may be filler oil. The technician must identify the source of the oil.
- (5) - If noise is isolated to shock or strut, suggest replacement.
- (6) - Although shocks or struts may have contributed to tire cupping, an inspection is needed of the entire suspension system. If the shock or strut is found to be contributing to the tire cupping, require replacement.

## SPINDLES

### SPINDLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Bent .....	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Race seat area		
undersized .....	B .....	Require replacement.
Scored .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## SPRINGS - COIL, LEAF AND TORSION BAR

When springs are replaced, it is suggested, but not required, that both springs on an axle be replaced to maintain equal height from side to side and to provide a balanced ride and proper handling.

When variable rate springs are installed in place of conventional coil springs, they must be installed in axle sets to ensure proper handling, uniform ride, and proper chassis height.

Erroneous height measurements may result from: improper tire inflation, non-standard tire or wheel size, and heavy load in vehicle or trunk.

### SPRING (COIL, LEAF AND TORSION BAR) INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B ....	Require repair or replacement of bent part.
Attaching hardware broken .....	A ....	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity ..	A ..	Require replacement of corroded part.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ....	Require repair or replacement of loose part.
Attaching hardware missing .....	C ...	Require replacement of missing part.
Attaching hardware threads damaged .....	A ....	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Broken (all springs except secondary leave(s) on multi-leaf springs) .....	A .....	Require replacement.
Coil clash .....	.. ..	(1) Require ride height check.
Coil spring insulator deteriorated .....	2 .....	Suggest replacement of insulator.
Coil spring insulator missing .....	2 .....	Suggest replacement of insulator.
Coil spring insulator split .....	2 .....	Suggest replacement of insulator.
Coil spring plastic coating deteriorated - rust present .....	A .....	(2) Refer to manufacturer's service requirements.
Composite spring damaged .....	.. ..	(3) Further inspection required.
Cracked (all springs except composite leaf and secondary leave(s) on multi-leaf springs) ...	A .....	Require replacement.
Installed incorrectly ..	B .....	Require repair.
Leaf spring insulators missing .....	2 .....	Suggest replacement of insulators.
Secondary leaf on multi-leaf spring broken ....	1 ....	Suggest repair or replacement
Secondary leaf on multi-leaf spring cracked ...	1 ....	Suggest repair or replacement
Torsion bar		

adjuster bent .....	A .....	(4) Require repair or replacement of adjuster.
Torsion bar adjuster seized .....	A ....	(4) Require repair or replacement of adjuster.
Torsion bar adjuster threads damaged .....	A ....	(4) Require repair or replacement of part with damaged threads.
Torsion bar adjuster threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Vehicle suspension height not within OEM specifications .....	B .....	Require adjustment or replacement.

- (1) - If vehicle is within manufacturer's height specifications, no service is suggested or required.
- (2) - Some manufacturers require replacement under these conditions.
- (3) - Check vehicle ride height. If ride height is OK, no service is suggested or required.
- (4) - Only required if ride height needs to be adjusted.

## STEEL POWER STEERING LINES

**CAUTION:** When replacing steel power steering lines, be sure to use a replacement product that meets or exceeds OEM design specifications.

### STEEL POWER STEERING LINE INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Blocked .....	A ..	Require repair or replacement.
Fitting incorrect (such as compression fitting) .....	B .....	Require replacement.
Flare type incorrect ....	B .....	Required replacement.
Leaking .....	A .....	Require tightening or replacement.
Line type incorrect .....	B .....	Require replacement.

Restricted .....	A .....	Require replacement.
Routed incorrectly .....	B .....	Require routing correction.
Rust-pitted .....	1 .....	Suggest replacement.
Rust pitted, affecting structural integrity ..	A .....	Require replacement.

## STEERING ARMS

### STEERING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Bent .....	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Taper hole elongated ....	A .....	(1) Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

(1) - Check for damaged stud.

## STEERING DAMPERS

The following procedures are only required if the vehicle was originally equipped from the factory with a steering damper. If the steering damper is an add-on unit, then the unit may be removed instead of repairing or replacing.

### STEERING DAMPER INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part, if available; otherwise, replace steering damper.
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise,

replace steering damper.

Attaching hardware corroded, affecting structural integrity ...	A	.	Require replacement of corroded part, if available; otherwise, replace steering damper.
Attaching hardware incorrect .....	A	.....	Require replacement of incorrect part, if available; otherwise, replace steering damper.
Attaching hardware loose .....	A	...	Require repair or replacement of loose part, if available; otherwise, replace steering damper.
Attaching hardware missing .....	C	..	Require replacement of missing part, if available; otherwise, replace steering damper.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace steering damper.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace steering damper.
Binding .....	A	.....	Require replacement.
Damper body dented .....	A	.....	(1) Further inspection required.
Damper body punctured ...	A	.....	Require replacement.
Damping (none) .....	A	.....	Require replacement.
Dust boot (bellows) missing .....	2	.....	(2) Suggest replacement of boot.
Dust boot (bellows) split .....	2	.....	(2) Suggest replacement of boot.
Dust shield broken .....	2	.....	(2) Suggest replacement.
Dust shield missing .....	2	.....	(2) Suggest replacement.
Leaking oil, enough for fluid to be running down the body .....	A	.....	Require replacement.
Loose .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Noise .....	2	.....	(3) Further inspection required.
Piston rod bent .....	A	.....	Require replacement.
Piston rod broken .....	A	.....	Require replacement.
Piston rod has surface defect .....	2	.....	Suggest replacement.
Piston rod threads stripped (threads missing) .....	A	.....	Require replacement.
Piston rod threads damaged .....	A	..	Require repair or replacement.
Seized .....	A	.....	Require replacement.

(1) - Require replacement of units where dents restrict damper

piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube dampers.

- (2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
- (3) - If noise is isolated to damper, suggest replacement.

## STEERING GEARS (EXCEPT RACK AND PINION)

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

### STEERING GEAR (EXCEPT RACK AND PINION) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ..	Require replacement of broken part.
Attaching hardware loose .....	A ..	Require repair or replacement of loose part.
Attaching hardware missing .....	C .....	Require replacement of missing part.
Attaching hardware threads damaged .....	A ..	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A ....	Require replacement of part with stripped threads.
Binding .....	A ...	Require repair or replacement
Flex coupler binding ....	A ...	Require repair or replacement of coupler.
Flex coupler loose .....	A ...	Require repair or replacement of coupler.
Flex coupler missing parts .....	A ...	Require repair or replacement of coupler.
Flex coupler soft/spongy .....	A .	Require replacement of coupler.
Flex coupler torn .....	A .	Require replacement of coupler.
Fluid contaminated .....	B .....	(1) Require flushing and refilling of the system.
Gasket leaking .....	A ...	Require repair or replacement of gasket.
Housing leaking .....	A .....	Require replacement.
Hydraulic fittings leaking .....	A ...	Require repair or replacement of fittings.
Inadequate power assist .	A .....	(2) Further inspection required. See note below.
Lash exceeds manufacturer's specifications .....	B ..	Require repair or replacement.
Seal leaking .....	A ...	Require repair or replacement

Splines damaged	.....	A	... of seal and/or mating part. Require repair or replacement of splines.
Splines stripped	.....	A	. Require replacement of splines.
Steering coupler shield cracked	.....	2	..... Suggest replacement.
Steering coupler shield missing	.....	C	..... Require replacement.
Threads damaged	.....	A	... Require repair or replacement of part with damaged threads.
Threads stripped (threads missing)	.....	A	..... Require replacement of part with stripped threads.
U-joint binding	.....	A	... Require repair or replacement of joint.
U-joint loose	.....	A	... Require repair or replacement of joint.
Unequal power assist	....	A	.. Require repair or replacement.
(1) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.			
(2) - If steering gear is source of inadequate assist, require repair or replacement.			

## STEERING GEARS - RACK AND PINION

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

### STEERING GEARS - RACK AND PINION INSPECTION

Condition	Code	Procedure
Attaching hardware broken	..... A	..... Require replacement of broken part.
Attaching hardware loose	..... A	.. Require repair or replacement of loose part.
Attaching hardware missing	..... C	..... Require replacement of missing part.
Attaching hardware threads damaged	..... A	.. Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	..... A	.... Require replacement of part with stripped threads.
Balance tube blocked	.... A	.. Require repair or replacement of balance tube.
Balance tube missing	.... C	.. Require replacement of balance tube.
Balance tube restricted	. A	... Require repair or replacement of balance tube.
Bellows boot clamp missing	..... C	... Require replacement of clamp.
Bellows boot cracked		



(not through) .....	2	..	Suggest replacement of bellows boot.
Bellows boot missing ....	C	..	Require replacement of bellows boot.
Bellows boot not sealing .....	A	...	Require repair or replacement of bellows boot.
Bellows boot torn .....	A	..	Require replacement of bellows boot.
Bellows boot twisted (from toe adjustment) ..	B	.....	Require repair.
Fitting leaking .....	A	..	Require repair or replacement.
Fitting missing .....	A	.	Require replacement of fitting.
Fitting threads damaged .....	A	...	Require repair or replacement of part with damaged threads.
Fitting threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Flex coupler binding ....	A	...	Require repair or replacement of coupler.
Flex coupler loose .....	A	...	Require repair or replacement of coupler.
Flex coupler missing parts .....	A	...	Require repair or replacement of coupler.
Flex coupler soft/spongy .....	A	.	Require replacement of coupler.
Flex coupler torn .....	A	.	Require replacement of coupler.
Fluid contaminated .....	B	.....	(1) Require flushing and refilling of the system.
Gasket leaking .....	A	..	Require repair or replacement.
Hard steering on cold start-up .....	1	.....	(2) Suggest repair or replacement.
Housing cracked, affecting structural integrity .....	B	.....	Require replacement.
Housing leaking .....	A	.....	Require replacement.
Inadequate power assist .	A	.....	(3) Further inspection required.
Lash exceeds manufacturer's specifications .....	B	..	Require repair or replacement.
Seal leaking .....	A	..	Require repair or replacement.
Splines damaged .....	A	..	Require repair or replacement.
Splines stripped (splines missing) .....	A	.....	Require replacement.
Steel line blocked .....	A	...	Require repair or replacement of line.
Steel line leaking .....	A	...	Require repair or replacement of line.
Steel line missing .....	C	....	Require replacement of line.
Steel line restricted ...	A	...	Require repair or replacement of line.
Steering coupler shield cracked .....	2	.....	Suggest replacement.
Steering coupler shield missing .....	C	.....	Require replacement.
Steering coupler shield torn .....	2	.....	Suggest replacement.
Threads damaged .....	A	...	Require repair or replacement of part with damaged threads.

Threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
U-joint binding .....	A	...	Require repair or replacement of joint.
U-joint loose .....	A	...	Require repair or replacement of joint.
Unequal power assist ....	A	..	Require repair or replacement.

- (1) - Determine and correct source of contamination. Follow OE specifications for fluid type.  
(2) - Indicates internal wear.  
(3) - If steering gear is source of inadequate assist, require repair or replacement.

## STEERING KNUCKLES

### STEERING KNUCKLE INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B	... Require repair or replacement of bent part.
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Bent .....	B	..... Require replacement.
Broken .....	A	..... Require replacement.
Pinch bolt incorrect ....	B	... Require replacement with bolt that meets OE design.
Pinch bolt loose .....	B	..... Require repair.
Pinch bolt missing .....	B	..... Require replacement.
Pinch bolt tabs deformed (pinched together), .032" or more before clamping .....	B	..... (1) Require replacement.
Taper hole elongated ....	A	..... (2) Require replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	.. Require repair or replacement.

- (1) - Steering knuckle deformation can cause pinch  
bolt breakage.  
(2) - Check for damaged stud.

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## STRIKE OUT BUMPERS

### STRIKE OUT BUMPER INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A .....	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity ...	A .....	Require replacement of corroded part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C .....	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Missing .....	C .....	Require replacement.
Split .....	1 .....	Suggest replacement.

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## STRUT RODS

### STRUT ROD INSPECTION

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Condition	Code	Procedure
Adjusting nut seized ....	A .....	(1) Require repair or replacement.
Attaching hardware bent .....	B ...	Require repair or replacement of bent part, if available; otherwise, replace strut rod.
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise, replace strut rod.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part, if available; otherwise, replace strut rod.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace strut rod.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace strut rod.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads,

if available; otherwise,  
replace strut rod.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace strut rod.
Attaching (mating) hole oversized .....	A	...	Require repair or replacement of frame.
Attaching point on frame corroded, affecting structural integrity ...	A	.....	Require repair of frame.
Bent .....	A	.....	Require replacement.
Mating (attaching) hole oversized .....	A	...	Require repair or replacement of frame.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - Only required if an alignment is being performed.

## STRUT UPPER BEARING PLATE ASSEMBLIES

NOTE: When the following guidelines indicate replacement of bearing, only the bearing should be replaced if it is available separately; otherwise, replace the bearing plate assembly.

### STRUT UPPER BEARING PLATE ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace bearing plate assembly.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace bearing plate assembly.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace bearing plate assembly.
Bearing axial or radial movement exceeds vehicle manufacturer's		

specifications .....	B	.....	Require replacement of bearing.
Bearing binding .....	A	.....	Require replacement of bearing.
Bearing missing .....	C	.....	Require replacement of bearing.
Bearing seized .....	A	.....	Require replacement of bearing.
Bent .....	B	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Missing .....	C	.....	Require replacement.
Severely corroded, affecting structural integrity .....	A	.....	Require replacement.

## SWAY BAR LINKS

### SWAY BAR LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace link.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace link.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace link.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace link.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace link.
Ball and socket has looseness (perceptible vertical movement) .....	1	..... (1) Suggest replacement.
Ball and socket has looseness that is excessive .....	B	..... (1)(2) Require replacement.
Bent .....	B	..... Require replacement.
Broken .....	A	..... Require replacement.
Corroded, affecting structural integrity ...	A	..... Require replacement.
Grease boot cracked .....	2	..... (3) Suggest replacement.
Grease boot missing .....	2	..... (4) Suggest replacement.
Grease boot torn .....	2	..... (5) Suggest replacement.
Missing .....	C	..... Require replacement.
Nut on stud loose .....	A	..... (6) Require repair.
Stud bent .....	B	..... (7) Require replacement.
Stud broken .....	A	..... (7) Require replacement.
Threads damaged .....	A	.. Require repair or replacement.

Threads stripped (threads missing) ..... A ..... (7) Require replacement.

- (1) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (2) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (3) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (6) - Check for bent stud or damaged taper hole.
- (7) - Check for damaged taper hole.

## SWAY BARS

### SWAY BAR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise, replace sway bar.
Attaching hardware corroded, affecting structural integrity ...	A .....	Require replacement of corroded part, if available; otherwise, replace sway bar.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace sway bar.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace sway bar.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads, if available; otherwise, replace sway bar.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads, if available; otherwise, replace sway bar.
Bent .....	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## TIE ROD ENDS (INNER AND OUTER)

## TIE ROD END (INNER AND OUTER) INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part, if available; otherwise, replace tie rod end.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace tie rod end.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace tie rod end.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads, if available; otherwise, replace tie rod end.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads, if available; otherwise, replace tie rod end.
Adjusting sleeve bent ...	B ...	Require replacement of sleeve or tie rod end.
Adjusting sleeve clamps out of position .....	B .....	Require repair.
Adjusting sleeve corroded, affecting structural integrity ...	A ...	Require replacement of sleeve or tie rod end.
Adjusting sleeve missing .....	C ...	Require replacement of sleeve or tie rod end.
Adjusting sleeve seized .....	A .....	(1) Require repair or replacement.
Adjusting sleeve threads damaged .....	A ...	Require repair or replacement of sleeve or tie rod end.
Adjusting sleeve threads stripped (threads missing) .....	A ...	Require replacement of sleeve or tie rod end.
Binding .....	A .....	(2) Further inspection required.
Grease boot cracked .....	2 .....	(3) Suggest replacement.
Grease boot missing .....	2 .....	(4) Suggest replacement.
Grease boot torn .....	2 .....	(5) Suggest replacement.
Grease fitting broken ...	A ...	Require replacement of grease fitting.
Grease fitting missing ..	C ...	Require replacement of grease fitting.
Grease fitting won't seal .....	A ...	Require replacement of grease fitting.
Grease seal missing .....	2 .....	(4) Suggest replacement of seal.

Grease seal torn .....	2	.....	(5) Suggest replacement of seal.
Greaseable tie rod end won't take grease .....	2	.....	(6) Suggest replacement of grease fitting.
Looseness (perceptible horizontal movement) ...	1	.....	(7) Suggest replacement.
Looseness exceeds manufacturer's specifications .....	B	.....	Require replacement.
Looseness that is excessive .....	B	.....	(7)(8) Require replacement.
Nut on stud loose .....	A	.....	(9) Require repair or replacement of nut.
Seized .....	A	.....	Require replacement
Stud bent .....	B	.....	(10) Require replacement.
Stud broken .....	A	.....	(10) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(10) Require replacement.

- (1) - Only required if toe needs to be adjusted.
  - (2) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
  - (3) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
  - (4) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
  - (5) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
  - (6) - If greaseable tie rod end will not take grease after replacing the grease fitting, suggest replacement of tie rod end.
  - (7) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
- CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
- (8) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
  - (9) - Check for bent stud or damaged taper hole.
  - (10) - Check for damaged taper hole.

## TRACK BARS

### TRACK BAR INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace track bar.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace track bar.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace track bar.
Attaching hardware		



threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace track bar.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace track bar.
Bent .....	B	.....	Require replacement.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Grease boot cracked .....	2	.....	(1) Suggest replacement.
Grease boot missing .....	2	.....	(2) Suggest replacement.
Grease boot torn .....	2	.....	(3) Suggest replacement.
Holes distorted .....	A	.....	Require replacement.
Looseness (perceptible horizontal movement) ...	1	.....	(4) Suggest replacement.
Looseness that is excessive .....	B	.....	(4) (5) Require replacement.
Nut on stud loose .....	A	.....	(6) Require repair or replacement of nut.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(7) Require replacement.
Stud broken .....	A	.....	(7) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(7) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (2) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (5) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (6) - Check for bent stud or damaged taper hole.
- (7) - Check for damaged taper hole.

## TRAILING ARMS

### TRAILING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace trailing arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available;

otherwise, replace trailing arm.

Attaching hardware missing .....	C	..	Require replacement of missing part, if available; otherwise, replace trailing arm.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace trailing arm.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace trailing arm.
Bent .....	B	.....	Require replacement.
Bushing hole oversized ..	B	.....	Require replacement.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

## WHEEL BEARINGS, RACES AND SEALS

NOTE: When replacing or repacking wheel bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

### WHEEL BEARING, RACE AND SEAL INSPECTION

Condition	Code	Procedure
Rear axle seal on rear-wheel drive leaking ....	A	..... Require replacement of seal and inspection of axle, bearing, housing, and vent tube.
Seal bent .....	1	..... Suggest replacement.
Seal leaking .....	A	. Require replacement of seal and inspection of bearings.
Seal missing .....	C	..... Require replacement.
Seal torn .....	A	..... Require replacement.
Wheel bearing assembly feels rough when rotated .....	A	.. Require replacement of bearing assembly.
Wheel bearing balls are pitted .....	A	.. Require replacement of bearing assembly.
Wheel bearing balls are worn .....	A	.. Require replacement of bearing assembly.
Wheel bearing end-play exceeds vehicle manufacturer's specifications .....	B	.. Require adjustment of bearing,

if possible. If proper adjustment cannot be obtained, require repair or replacement of worn component.

Wheel bearing race is loose in the hub bore .....	A	.....	Require replacement of hub assembly and wheel bearings.
Wheel bearing races are pitted .....	A	..	Require replacement of bearing assembly.
Wheel bearing races are worn .....	A	..	Require replacement of bearing assembly.
Wheel bearing rollers are pitted .....	A	..	Require replacement of bearing assembly.
Wheel bearing rollers are worn .....	A	..	Require replacement of bearing assembly.

## WHEEL ALIGNMENT

### WHEEL ALIGNMENT

Wheel alignment is defined as the measurement, analysis, and adjustment of steering and suspension angles to conform to OEM specifications. These angles usually include, but are not limited to: caster, camber, toe, and thrust angle. Where these angles are not adjustable and not in specification, component replacement or correction kits may be required. Errors in set-back and steering axis inclination (SAI) are often attributable to failed or damaged components and must be corrected prior to performing an alignment.

Failure to replace or correct suggested parts or service may prevent a proper alignment.

Before performing an alignment check, inspect and verify the following:

- \* Tire pressure and size
- \* Vehicle loading
- \* Ride height
- \* Steering and suspension parts

If the inspection reveals that all the above are within published specifications, a wheel alignment check and an alignment, if needed, may be performed.

**CAUTION:** Under no circumstances should a technician bend or heat any steering or suspension component, unless specified by the vehicle manufacturer, for example, Ford forged twin "I" beam axles. All measurements and specifications must be noted on the inspection report.

### WHEEL ALIGNMENT INSPECTION

Condition	Code	Procedure
Dog tracking, shown to be caused by faulty alignment .....	2	Suggest repair.
Lead, shown to		

be caused by faulty alignment	.....	A	.....	Require alignment.
Part has been changed, affecting alignment	....	A	.....	Require alignment check.
Pull, shown to be caused by faulty alignment	....	A	.....	Require alignment.
Steering wheel off-center	.....	2	.....	Suggest alignment.
Tire wear, shown to be caused by faulty alignment	.....	A	.....	Require alignment.
Wander, shown to be caused by faulty alignment	.....	A	.....	Require alignment.

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## WHEELS AND TIRES

### TIRES

These guidelines do not apply to split rims. Some vehicle manufacturers restrict replacement of tires to specific brands, types, or sizes.

**WARNING:** High pressure temporary compact spare tires should not be used with any other rims or wheels, nor should standard tires, snow tires, wheel covers, or trim rings be used with high pressure compact spare rims or wheels. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death.

**WARNING:** Only specially trained persons should dismount or mount tires. Explosions of tire and wheel assembly can result from improper mounting, possibly causing serious injury or death.

**WARNING:** Consult the vehicle owner's manual or vehicle placard for correct size, speed rating, designation, and cold inflation pressure of the original tires. DO NOT exceed the maximum load or inflation capacity of the tire specified by the Tire and Rim Association

**WARNING:** When replacing tires, it is suggested that the replacement tires match or exceed the OEM speed rating designation. If tires of different speed rating designations are mixed on the same vehicle, the tires may vary in handling characteristics. DO NOT mix different speed rating designations on the same axle.

**WARNING:** DO NOT mix radials with non-radial tires on the same axle, as this may affect vehicle handling and stability. If radial tires and bias or bias-belted ply tires are mixed on the same vehicle, the radials must be on the rear. High-pressure temporary compact spare tires are exempt from this rule.

**WARNING:** DO NOT mix size or type (all season, performance, mud and snow) of tires on the same axle.

### TIRE INSPECTION

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Condition	Code	Procedure
Air pressure incorrect ..	B	..... Require repair
Bead broken .....	A	..... Require replacement.
Bead leaking, caused by tire .....	A	.. Require repair or replacement.
Bead wire/cord exposed ..	A	..... Require replacement.
Cord or belt material exposed .....	A	..... Require replacement.
Cord ply separations ....	A	..... Require replacement.
Directional/asymmetrical tires mounted incorrectly .....	B	..... Require remounting and/or repositioning.
Irregular tread wear, affecting performance ..	2	..... (1) Suggest replacement.
Load ratings less than OEM specifications .....	B	..... Require replacement.
Mixed tread types (all season, performance, mud and snow) on same axle .	A	..... Require replacement.
Number of punctures exceeds manufacturer's limit .....	B	..... Require replacement.
Out of balance .....	B	. Require rebalance of tire/wheel assembly.
Ply separation .....	A	..... Require replacement.
Pull or lead, caused by tire .....	A	.. Require repair or replacement.
Radial and bias or bias-belted ply tires on same axle .....	B	.. Require repair or replacement.
Radials are on the front and not on the rear ....	B	..... (2) Require repair or replacement.
Run flat damage .....	A	..... Require replacement.
Shoulder cut .....	A	..... Require replacement.
Shoulder puncture .....	A	..... Require replacement.
Shoulder with plug .....	A	..... Require replacement.
Sidewall bulge .....	A	..... Require replacement.
Sidewall cut .....	A	..... Require replacement.
Sidewall indentation ....	..	..... No service required or suggested.
Sidewall puncture .....	A	..... Require replacement.
Sidewall with plug .....	A	..... Require replacement.
Speed rating designations different on same axle .....	2	.. Suggest repair or replacement.
Tire and wheel assembly has excessive run-out ..	B	..... (3) Require repair or replacement of appropriate part.
Tires with more than 1/4" diameter difference on a four-wheel drive vehicle .....	B	..... Require replacement.
Tread area puncture larger in diameter than manufacturer's specifications .....	B	..... Require replacement.
Tread missing pieces		

- (1) - Determine and correct cause of irregular tire wear.
- (2) - If radials and bias or bias-belted ply tires are on the same vehicle, the radials must be on the rear axle, except for high-pressure temporary spares.
- (3) - Excessive is defined as enough to contribute to performance problems. Match mounting may correct run-out. If not, require replacement of appropriate part. Refer to manufacturer's specifications.
- (4) - Most manufacturers do not recommend tubes in tubeless tires. Inspect tire and wheel assembly to determine the reason for a tube in tubeless tire. Recommendation for repair or replacement should be based upon condition of tires and/or wheel listed in these guidelines.

## VALVE STEM INSPECTION

Condition	Code	Procedure
Bent .....	1	Suggest replacement.
Broken .....	A	Require replacement.
Cut, but not leaking ....	1	Suggest replacement.
Deteriorated (cracking, dry rot) ....	1	Suggest replacement.
Leaking .....	A	Require repair or replacement.
Missing .....	C	Require replacement.
Threads damaged .....	A	Require repair or replacement.
Threads stripped .....	A	Require replacement.
Valve cap missing .....	C	Require replacement of cap.
Weather-checking .....	1	Suggest replacement.
Won't take air .....	A	Require repair or replacement.

For conditions noted below, also check conditions of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow recommended torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

Condition	Code	Procedure
Bent .....	A .....	Require replacement.
Broken .....	A ..... (1)	Require replacement.

Loose .....	B	...	Require repair or replacement of affected component.
Lug nut installed backward .....	B	..	Require repair or replacement.
Lug nut mating type incorrect .....	B	.....	Require replacement of nut.
Lug nut mating surface dished .....	A	.....	Require replacement of nut.
Lug nut rounded .....	A	.	(2) Require replacement of nut.
Lug nut seized .....	A	.	(2) Require replacement of nut.
Stud incorrect .....	B	....	Require replacement of stud.
Threads damaged .....	A	...	Require repair or replacement of component with damaged threads.
Threads stripped .....	A	.....	Require replacement of component with stripped threads.

- (1) - Some manufacturers require replacement of all studs on that wheel if two or more studs or nuts on the same wheel are broken or missing.
- (2) - Only required if removing wheel.
- 

## WHEELS (RIMS)

**WARNING:** Mounting a regular tire on a high-pressure compact spare wheel is not permitted. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death. If the wheel identification stamp is not legible, or cannot be found, do not use the wheel until the size and type have been properly identified. Wheels of different diameter, offset, or width cannot be mixed on the same axle. Bead seat tapers cannot be interchanged.

### WHEEL (RIM) INSPECTION

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Condition	Code	Procedure
Bead leaking, caused by wheel .....	A	..... (1) Require repair or replacement.
Bent hub mounting surface .....	A	..... Require replacement.
Bent rim, causing vibration .....	2	..... (1) Suggest replacement.
Broken .....	A	..... Require replacement.
Cast wheel porous, causing a leak .....	A	.. Require repair or replacement.
Clip-on balance weight is incorrect type for rim flange .....	2	..... Suggest replacement.
Corrosion, affecting structural integrity ...	A	..... Require replacement.
Corrosion build-up on wheel mounting surface .....	A	..... Require repair.
Cracked .....	A	..... Require replacement.
Directional/asymmetrical wheels mounted incorrectly .....	B	..... Require remounting and/or repositioning.

Load capacity less than OEM specifications .....	B	.....	Require replacement.
Offset mismatched on same axle .....	B	.....	Require replacement.
Rivets leaking .....	A	.....	Require replacement.
Run-out beyond OEM specs .....	B	.....	Require replacement.
Stud holes elongated ....	A	..... (2)	Require replacement.
Welded or brazed repair .....	2	.....	Suggest replacement.
Welds leaking .....	A	.....	Require replacement.
Wheel centering (pilot) hole incorrect .....	B	.....	Require replacement.

(1) - CAUTION: DO NOT attempt to correct a bent rim.

(2) - Inspect wheel attaching hardware for damage.

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# STEERING COLUMN SWITCHES

## 1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Steering Column Switches

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION

NOTE: Grand Cherokee and Grand Wagoneer are equipped with a combination switch incorporating headlight, turn signal, wiper, hazard and dimmer functions.

### DISABLING & ACTIVATING

#### AIR BAG

WARNING: Grand Cherokee and Grand Wagoneer are equipped with Supplemental Restraint System (SRS), air bag system MUST be disabled before servicing ANY steering column component. Disabling system will prevent accidental air bag deployment, resulting in possible serious injury or property damage.

BEFORE servicing ANY steering column or air bag component, disconnect and shield negative (ground) battery cable. Wait 2 minutes to allow air bag system capacitor to deplete its residual charge. Proceed with steering column service.

### TESTING

#### HEADLIGHT DIMMER SWITCH

Cherokee & Wrangler

1) Position headlight switch in ON position. Position dimmer switch in HIGH or LOW beam position.

2) Measure voltage between dimmer switch connector voltage supply terminal and vehicle body ground. Voltmeter should indicate battery voltage. If not, repair open circuit in wire harness between headlight switch and dimmer switch.

3) Position dimmer switch in LOW beam position. Measure voltage between dimmer switch connector low beam voltage out terminal and vehicle body ground. Voltmeter should indicate battery voltage. If not, replace dimmer switch.

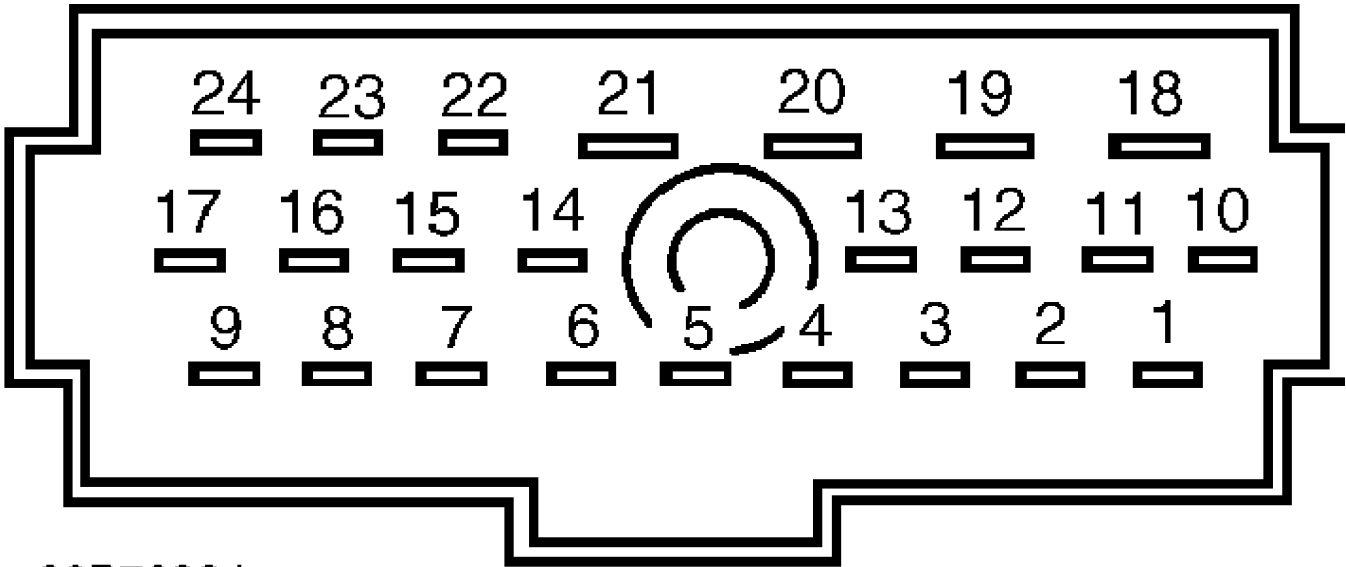
4) Position dimmer switch in HIGH beam position. Measure voltage between dimmer switch connector high beam voltage out terminal and vehicle body ground. Voltmeter should indicate battery voltage. If not, replace dimmer switch.

Grand Cherokee & Grand Wagoneer

1) Disconnect negative battery cable. Remove tilt lever (if equipped). Remove upper and lower steering column trim covers. Remove knee blocker. Remove steering column mounting nuts.

2) Lower steering column to gain access to rear of combination switch. Using Remover (TTXR20B2), remove tamper-proof mounting screws. Gently pull combination switch away from steering column. Loosen connector screw sufficiently to remove connector. Screw will remain in connector. Remove connector. Using ohmmeter, check for continuity in turn signal and hazard warning terminals of combination switch with turned to indicated positions. See Fig. 1. Refer to the DIMMER SWITCH CONTINUITY table. If continuity is not as specified,

replace combination switch as an assembly.



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Fig. 1: Combination Switch Pins ID (Grand Cherokee & Grand Wagoneer)  
Courtesy of Chrysler Corp.

DIMMER SWITCH CONTINUITY TABLE (GRAND CHEROKEE & GRAND WAGONEER)

Function	Pin Continuity
Low Beam .....	18 & 19
High Beam .....	19 & 20
Optical Horn .....	20 & 21

HAZARD SWITCH

Cherokee

1) Ensure fuse for hazard flasher is good. Measure voltage at fuse side of flasher (side terminal). If battery voltage is present, go to next step. If battery voltage is not present, repair open circuit between fuse and hazard flasher.

2) Replace hazard flasher. Lights should flash. If lights do not flash, measure voltage at turn signal switch connector between Violet/Tan wire and ground. If battery voltage is present, replace hazard/turn signal combination switch. If battery voltage is not present, repair open in Violet/Tan wire.

Grand Cherokee & Grand Wagoneer  
See TURN SIGNAL SWITCH.

Wrangler

Ensure fuse for hazard flasher is good. Measure voltage at battery side of hazard fuse flasher terminal "A". If battery voltage is not present, repair open circuit from fuse No. 5.

HEADLIGHT SWITCH

Cherokee & Wrangler

1) Place headlight switch in ON position. Measure voltage between headlight switch connector voltage supply terminal and ground.

Voltmeter should indicate battery voltage. If battery voltage is not indicated, repair open circuit in wire harness between fuse and switch connector terminal.

2) Measure voltage between headlight switch connector voltage supply terminal and ground. Battery voltage should be present. If battery voltage is not indicated, repair open circuit in wire harness between fuse and switch connector terminal.

3) Measure voltage between headlight switch connector battery voltage out terminal and ground. Voltmeter should indicate battery voltage. If battery voltage is not indicated, replace headlight switch.

Grand Cherokee & Grand Wagoneer  
See HEADLIGHT DIMMER SWITCH.

## HORN

Cherokee

1) Inspect headlight delay fuse, and replace if necessary. Relay contacts should click when horn switch is depressed. If relay clicks, go to step 4). If relay does not click, remove relay located on bracket (3 relays) behind instrument panel. Check voltage at relay connector between Gray/Orange wire and ground. If battery voltage exists, go to next step. If battery voltage does not exist, repair open in Gray/Orange wire.

2) Depress horn switch. Check resistance at relay connector between Black/Red wire and ground. If reading is zero ohms, go to next step. If reading is not zero ohms, repair horn switch ground.

3) Check resistance at relay connector between Green/Red wire and ground. Resistance should be almost zero ohms (horn resistance). If resistance is as specified, replace relay. If resistance is not as specified, repair open in circuit between relay and horns (Green/Red wire).

4) Disconnect horn connector. Depress horn switch. Check voltage at horn connector between Green/Red wire and ground. If battery voltage does not exist, go to next step. If battery voltage exists, replace horns.

5) Check resistance between horn bracket and chassis ground. Resistance should be zero ohms. If resistance is not zero ohms, check mounting screw for corrosion and repair or replace as necessary.

Grand Cherokee & Grand Wagoneer

1) Check fuse No. 13 in fuse block. Replace fuse, if necessary. Depress horn switch. Horn relay (Black), located in relay center under glove box, should click audibly. If relay clicks, go to step 5). If relay does not click, remove relay.

2) Relay cavities in relay center are numbered. Check for battery voltage in cavity No. 1. Battery voltage should exist. If battery voltage does not exist, repair open in circuit between fuse block and relay center.

3) Depress horn switch. Check resistance between cavity No. 2 and ground. If resistance is greater than zero ohms, repair open in switch ground.

4) Check resistance between relay cavity No. 4 and ground. Resistance should be nearly zero ohms (horn resistance). If resistance is as specified, replace horn relay. If resistance is not as specified, repair open in Dark Green wire between relay and horn.

5) Disconnect horn connector. Depress horn switch. Check voltage at horn connector between Dark Green wire and ground. If battery voltage does not exist, go to next step. If battery voltage exists, replace horns.

6) Check resistance at horn connector between Black wire and chassis ground. Resistance should be zero ohms. If resistance is not

zero ohms, repair open in Black wire to ground.

#### Wrangler

1) Check 10-amp fuse (fuse No. F15) located in fuse block below flashers. Replace fuse as necessary. Relay contacts should click when horn switch is depressed. If relay does not click, go to next step. If relay clicks, go to step 5).

2) Remove relay. Relay is taped in wiring harness above fuse panel. Check voltage at relay connector between Red/White wire and ground. If battery voltage exists, go to next step. If battery voltage does not exist, repair open in Red/White wire.

3) Depress horn switch. Check resistance at relay connector between Orange/White wire and ground. If resistance is almost zero ohms, go to next step. If resistance is not almost zero ohms, repair horn switch ground.

4) Check resistance at relay connector between Gray/Orange wire and ground. Reading should be almost zero ohms (horn resistance). If resistance is as specified, replace relay. If resistance is not as specified, repair open in Gray/Orange wire between relay and horns.

5) Disconnect horn connector. Depress horn switch. Check voltage at horn connector between Gray/Orange wire and ground. If battery voltage does not exist, go to next step. If battery voltage exists, replace horns.

6) Check resistance at horn connector between Black wire and chassis ground. Resistance should be zero ohms. If resistance is not zero ohms, repair open in Black wire to ground.

### IGNITION SWITCH TEST

Except Grand Cherokee & Grand Wagoneer

1) Remove ignition switch. See IGNITION SWITCH R & I under REMOVAL & INSTALLATION. Using an ohmmeter or self-powered test light, check ignition positions for continuity between terminals. See Fig. 2. Also, see the IGNITION SWITCH TERMINAL CONNECTIONS table.

2) Identify ignition switch slide bar positions by locating alignment hole in flat portion of switch, adjacent to terminals. Starting from alignment hole end of switch, positions are ACC, OFF-LOCK, OFF, ON and START. Each position has a detent stop except START position, which is spring-loaded. There should be no resistance between any 2 connected terminals. If switch does not function as specified, replace switch.

Grand Cherokee & Grand Wagoneer

Testing procedures are not available from manufacturer.

#### IGNITION SWITCH TERMINAL CONNECTIONS TABLE

Switch Position	Continuity Between	Circuit Result
ACC .....	A & B2 .....	Connected
OFF-LOCK .....	N/A .....	Open
OFF .....	N/A .....	Open
ON .....	I1 & B1 (1) .....	Connected
" .....	A & B2 (1) .....	Connected
" .....	I3 & B3 (1) .....	Connected
START .....	I1, B1 & S .....	Connected
" .....	G1 & G2 .....	Grounded

(1) - Terminals B1, B2 and B3 are all connected to battery circuit.

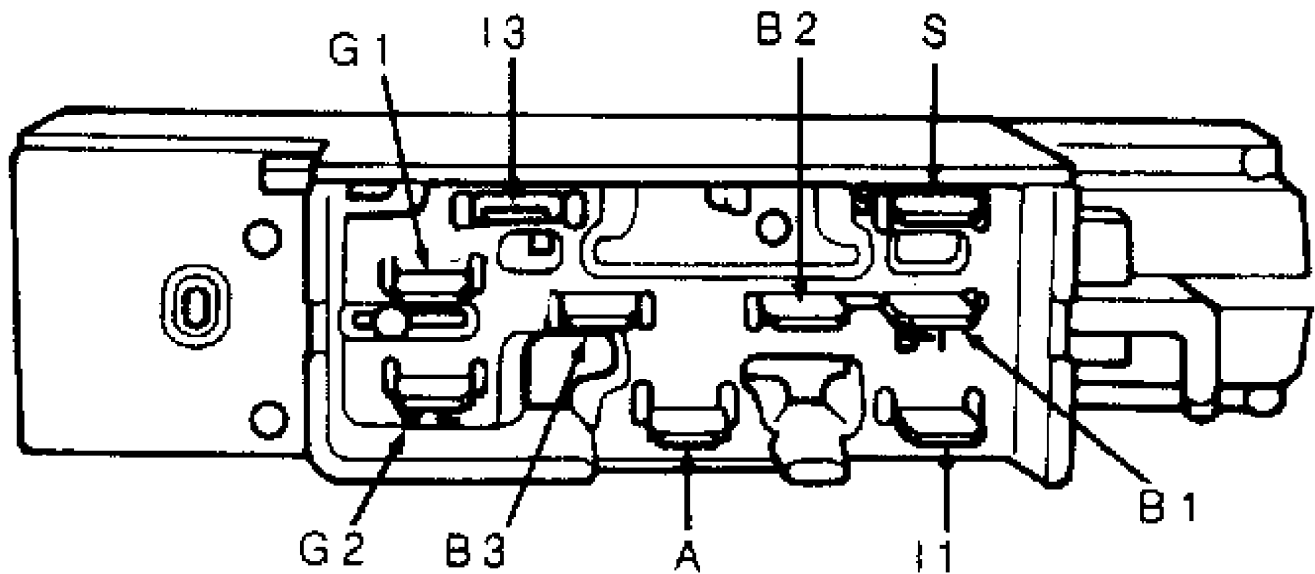


Fig. 2: Locating Ignition Switch Terminals  
 Courtesy of Chrysler Corp.

TURN SIGNAL SWITCH

Cherokee

- 1) Remove and inspect TURN fuse. Replace as necessary. Turn ignition switch to ACC position. Place turn signal switch in left turn signal position, and pull hazard switch out. Measure voltage at turn signal flasher between Yellow/Black wire (bottom terminal) and ground. If battery voltage is present, go to next step. If battery voltage is not present, repair open in Yellow/Black wire.
- 2) Replace turn signal flasher with 2-lamp, 12-volt rated flasher. Turn signals should flash. If turn signals do not flash, measure voltage at turn signal/hazard switch connector between Black wire and ground. If battery voltage is present, replace turn signal/hazard switch assembly. If battery voltage is not present, repair open circuit to hazard flasher.

Grand Cherokee & Grand Wagoneer

- 1) Disconnect combination switch connector. Using ohmmeter, check for continuity in turn signal and hazard warning terminals of combination switch with turned to indicated positions. See Fig. 1. See the TURN SIGNAL SWITCH CONTINUITY table. If continuity is not as specified, combination switch must be replaced as an assembly.

TURN SIGNAL SWITCH CONTINUITY TABLE (GRAND CHEROKEE & GRAND WAGONEER)

Function	Pin Continuity
Turn Signal Switch	
Neutral .....	12, 14 & 15
Left .....	15, 16 & 17; 12 & 14; (1) 22 & 23
Right .....	11, 12 & 17; 14 & 15; (1) 23 & 24
Hazard Switch .....	11, 12, 13, 15 & 16

(1) - With optional corner lamps.

Wrangler

- Disconnect turn signal/hazard switch connector. Pull hazard

switch on. Measure resistance at turn signal/hazard switch connector. Measure between specified wires with turn signal switch in correct position. See the TURN SIGNAL SWITCH TEST SPECIFICATIONS (WRANGLER) table. If switch does not test as specified, replace switch.

#### TURN SIGNAL SWITCH TEST SPECIFICATIONS (WRANGLER)

Switch Position	Wire Color	Ohms
Left Turn .....	Violet & Yellow .....	Zero
" .....	Violet & Light Blue .....	Zero
Right Turn .....	Violet & Dark Green .....	Zero
" .....	Violet & Dark Blue .....	Zero

## WIPER SWITCH

For testing information, see WIPER/WASHER SYSTEMS article.

## REMOVAL & INSTALLATION

### STEERING WHEEL & HORN PAD R & I

#### Removal & Installation (Cherokee & Wrangler)

1) On standard steering wheel, remove 3 screws on rear of steering wheel and remove horn pad. On sport steering wheel (round horn button), remove bushing, receiver and flex plate from steering wheel. On all models, remove steering wheel retaining nut. Mark steering wheel and shaft for reassembly reference. Using steering wheel puller, remove steering wheel.

2) To install, reverse removal procedure. Ensure marks are aligned. Tighten steering wheel nut to specification. Refer to the TORQUE SPECIFICATIONS table. Replace negative battery cable. Check horn and turn signal for correct operation. Reset clock and radio stations if necessary.

#### Removal & Installation (Grand Cherokee & Grand Wagoneer)

1) Disable air bag system. See AIR BAG DISABLING. Ensure steering wheel is in straight-ahead position. Remove nuts mounting air bag module to steering wheel. Remove screws securing cruise control switch to steering wheel. Disconnect wiring connectors. Remove air bag module and cruise control switch assembly.

2) Pry trim covers from back of steering wheel and remove horn switch mounting screws. Disconnect horn wires. Remove horn switch.

3) Remove steering wheel retaining nut. Reference mark steering wheel and steering shaft. Using puller, remove steering wheel. To install, reverse removal procedure. Align marks made during removal. Tighten steering wheel retaining nut to specification.

### COMBINATION SWITCH R & I

#### Removal & Installation (Grand Cherokee & Grand Wagoneer)

1) Disable air bag system. See AIR BAG DISABLING. Remove tilt lever (if equipped). Remove upper and lower steering column covers. Remove steering panel trim panel and knee bolster. Remove steering column-to-mounting bracket retaining nuts. Lower steering column.

2) Using Tamper-Proof Torx Bit (TTXR20B2), remove combination switch retaining screws. Gently roll combination switch away from column. Unscrew connector retaining screw from combination switch. Screw will remain in connector. Disconnect connector. Remove switch. To install, reverse removal procedure.

## IGNITION SWITCH R & I

### Removal (Cherokee & Wrangler)

1) Disconnect negative battery cable. On Cherokee, remove lower instrument panel trim panel. On Wrangler, remove windshield wiper intermittent control module and bracket. Place ignition key lock in ACC position.

2) Remove 2 headlight dimmer switch attaching nuts. Before removing dimmer switch, tape 2 actuator rods to steering column to prevent accidental disengagement from upper part of steering column. Lift switch off lock rod.

3) Remove ignition switch-to-steering column attaching screws. Disengage ignition switch from remote actuator rod by lifting it straight up. Remove switch from steering column.

### Installation (Cherokee & Wrangler)

1) Place key lock switch in ACC position. Move position slider of switch to ACC position. Connect non-Black connector to switch, then connect Black connector to switch. One connector will interlock the other connector.

2) Slip remote actuator rod into access hole on switch. Install switch to steering column. Use care not to move slider bar on switch out of ACC detent position. Remove ignition switch actuator rod securing tape from steering column.

3) Install 2 ignition switch-to-steering column screws finger tight. DO NOT tighten screws yet.

4) To adjust ignition switch on non-tilt steering column, hold key lock in ACC position. Gently slide ignition switch up toward steering wheel. This will remove slack from switch. Tighten screws. DO NOT allow ignition switch to move from ACC detent position.

5) To adjust ignition switch on tilt steering column, hold key lock switch in ACC position. Gently slide ignition switch down away from steering wheel. This will remove slack from switch. Tighten attaching screws. DO NOT allow switch to move from ACC detent position.

6) On all models, ignition switch and headlight dimmer switch share 2 mounting screws. One mounting screw must be removed from ignition switch. This must be done after ignition switch has been adjusted, and before dimmer switch has been installed. Remove one screw, but do not remove stud/nut.

7) Slip headlight dimmer switch into actuator rod and position over ignition switch. Install screws finger tight. Remove dimmer switch actuator rod securing tape from steering column.

8) Adjust dimmer switch by depressing it slightly and inserting a 3/32" drill bit into adjustment hole to prevent horizontal switch movement. Move switch toward steering wheel to remove any lash from switch actuator rod. Tighten dimmer and ignition switch retaining nuts to 35 INCH lbs. (4 N.m). To complete installation, reverse removal procedure.

### Removal (Grand Cherokee & Grand Wagoneer)

1) Disconnect negative battery cable. Remove tilt lever (if equipped). Remove upper and lower steering column covers. Remove ignition switch mounting screws. Gently pull switch away from steering column.

2) Release connector locks on 7-pin and 4-pin connectors. Pull connectors from switch body. Turn key to LOCK position. Using small screwdriver, depress lock cylinder retaining pin. Rotate key to OFF position. Remove lock cylinder.

NOTE: When ignition switch is in LOCK position, flag on park/lock pin at rear of switch will be parallel with 7-pin connector

terminals.

#### Installation (Grand Cherokee & Grand Wagoneer)

1) Install connectors in switch body. Ensure connector locks are engaged. Ensure switch is in LOCK position. Apply small amount of grease to park/lock pin and flag. Mount ignition switch on steering column. Ensure park/lock pin at back of switch engages park/lock slider linkage. Tighten mounting screws to 17 INCH lbs. (2 N.m).

2) Install steering column covers. Install tilt lever (if equipped). Connect negative battery cable. Ensure lock cylinder and ignition switch are in LOCK position. Insert lock cylinder in switch until it bottoms. Insert key and rotate clockwise to end of travel. Check for proper switch operation.

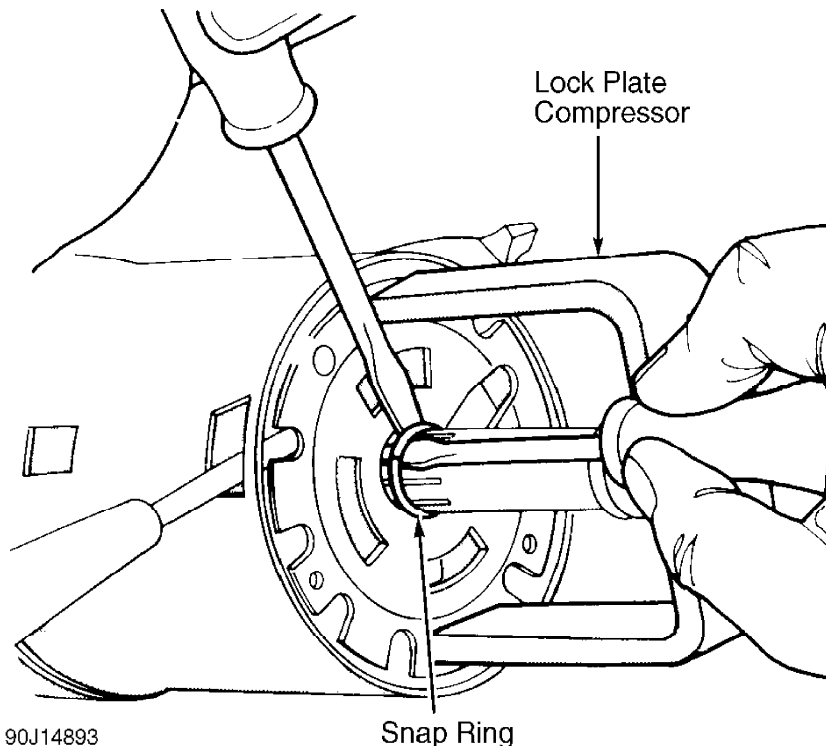
### LOCK CYLINDER R & I

#### Removal (Cherokee & Wrangler)

1) Disconnect negative battery cable. Remove horn/trim cover retaining screws from back of steering wheel. Remove steering wheel. Disconnect horn wiring. On sport steering wheel (round horn button), pull button upward, and remove horn components.

2) Remove steering wheel retaining nut and vibration dampener. Mark steering shaft and steering wheel for reassembly reference. Use proper steering wheel puller to avoid damaging shaft or threads.

3) Remove lock plate plastic cover. Compress lock plate using Lock Plate Compressor (J-23653 for standard threads or J-23653-4 for Metric threads). See Fig. 3. Pry retaining snap ring from steering shaft groove, and slide snap ring toward compressor.



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Fig. 3: Removing Lock Plate & Snap Ring  
Courtesy of Chrysler Corp.

4) Unscrew and remove compressor. Remove snap ring, lock plate, canceling cam and spring from steering shaft. Remove hazard



warning switch knob from side of column by pushing inward on knob and turning it counterclockwise. Remove turn signal switch retaining screw. Remove turn signal/wiper switch rod.

**WARNING:** Lock plate is held by high pressure spring. DO NOT remove snap ring without using lock plate compressor.

5) Disconnect wire harness connector on bracket at lower end of steering column. Remove 3 turn signal switch retaining screws. Pull switch outward toward end of shaft. DO NOT dislodge dimmer switch rod.

6) Insert paper clip below retainer so retainer is flattened. See Fig. 4. Using needle-nose pliers, remove key warning buzzer switch and contacts as an assembly.

7) Remove lock cylinder retaining screw. Insert ignition key into lock cylinder and turn to ON position. Pull out lock cylinder.

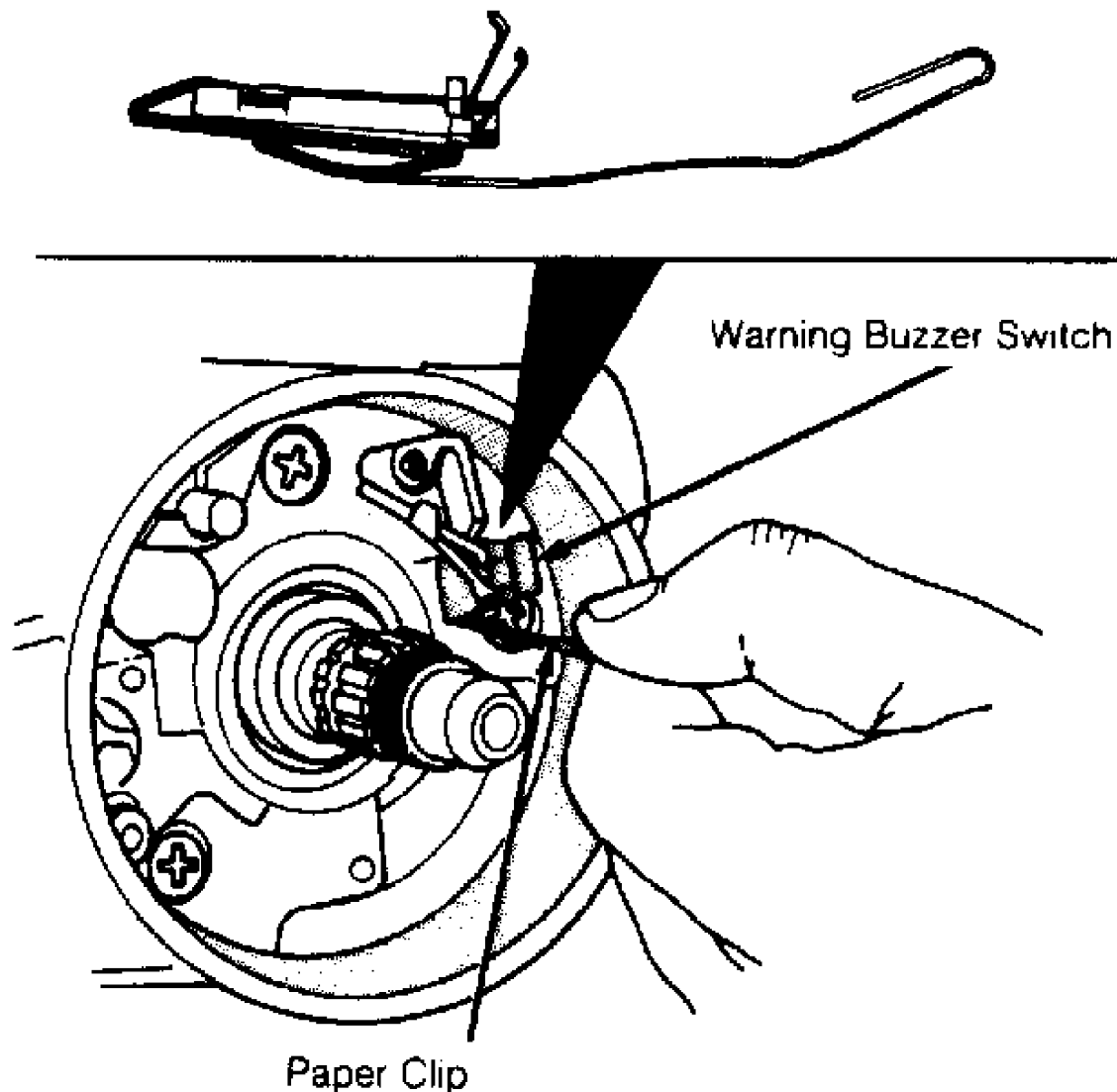


Fig. 4: Removing Warning Buzzer Switch  
Courtesy of Chrysler Corp.

Installation (Cherokee & Wrangler)

To install, reverse removal procedure. Ensure lock cylinder

bottoms in bore and engages into gear for ignition switch rod by turning key. Fit warning buzzer, with contacts separated, in place. Before tightening screws, ensure dimmer switch rod is in socket in turn signal switch.

Removal & Installation (Grand Cherokee & Grand Wagoneer)  
See IGNITION SWITCH R & I.

## TURN SIGNAL & HAZARD FLASHER SWITCH R & I

Removal & Installation (Cherokee & Wrangler)

1) Place front wheels in straight-ahead position. Disconnect the negative battery cable. Remove the steering wheel. Refer to STEERING WHEEL & HORN PAD R & I.

2) On column shift models, remove selector lever retaining pin and lever. On all models, use 2 screwdrivers to remove lock plate cover (if equipped). See Fig. 5.

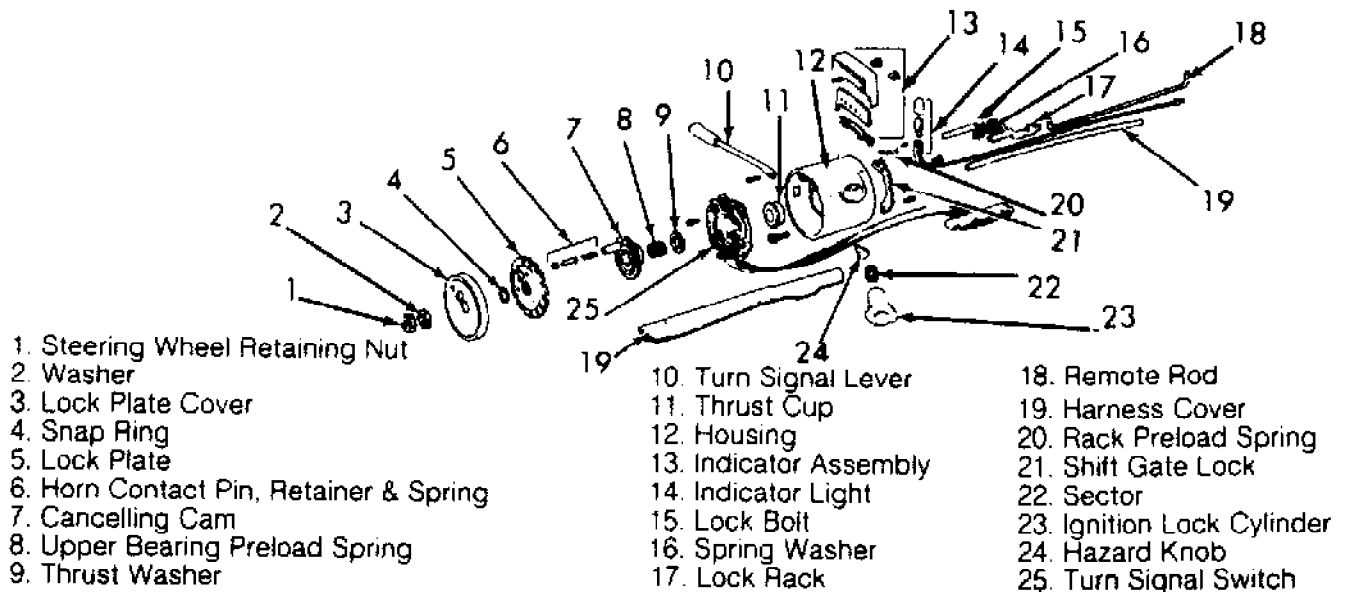


Fig. 5: Exploded View Of Typical Steering Column Switch Assembly  
Courtesy of Chrysler Corp.

3) Using lock plate compressor, compress lock plate. See Fig. 3. Remove and discard lock plate snap ring. Remove plate compressor.

**WARNING:** Lock plate is under strong spring tension. DO NOT attempt to remove snap ring without using lock plate compressor.

4) Remove lock plate, canceling cam, upper bearing preload spring and thrust washer. See Fig. 5. Depress hazard warning switch knob and rotate counterclockwise to remove.

5) On column shift models, remove gear selector cover and shift indicator light bracket screw. DO NOT remove light bracket. On tilt models, remove tilt lever.

6) On all models, disconnect switch wiring harness connector from bracket located at lower end of steering column. Wrap tape around connector for ease of switch removal.

7) Remove plastic protector from wiring harness (if equipped). Remove turn signal switch attaching screws and dimmer switch arm. Remove turn signal switch. To install, reverse removal

procedure. Tighten turn signal switch screws to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Install NEW lock plate snap ring.

**TORQUE SPECIFICATIONS**

TORQUE SPECIFICATIONS TABLE

Application		Ft. Lbs. (N.m)	
Steering Wheel Nut	.....	25	(34)
		INCH Lbs. (N.m)	
Dimmer Switch Nuts	.....	35	(4)
Ignition Switch			
Nuts (Cherokee & Wrangler)	.....	35	(4)
Screws (Grand Cherokee & Grand Wagoneer)	.....	17	(2)
Turn Signal Mounting Screws	.....	35	(4)

# **\* SUSPENSION UNIFORM INSPECTION GUIDELINES \***

1993 Jeep Cherokee

## GENERAL INFORMATION

Steering, Suspension, Wheel Alignment, Wheels and Tires  
Motorist Assurance Program  
Standards For Automotive Repair

All Makes and Models

## **INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)**

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CONTROL ARMS

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Wheel Alignment

WHEEL ALIGNMENT

Wheels and Tires

TIRES  
VALVE STEMS  
WHEEL ATTACHMENT HARDWARE  
WHEELS (RIMS)

## **MOTORIST ASSURANCE PROGRAM (MAP)**

### **OVERVIEW**

The Motorist Assurance Program is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

Our organization's mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take greater responsibility for their vehicles—through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt 1) a Pledge of Assurance to their Customers and 2) the Motorist Assurance Program Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service demonstrating to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made and the results communicated to the customer according to industry standards. Given that the industry did not have such standards, the Motorist Assurance Program successfully promulgated industry inspection communication standards in 1994-95 for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical Systems. Further, revisions to all of these inspection communication standards are continually re-published. In addition to these, standards for Drive Train and Transmissions have recently been promulgated. Participating shops utilize these Uniform Inspection & Communication Standards as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials (and their representatives), concerned with auto repair and/or consumer protection, are conducted. Feedback from these sessions is brought back to the association, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers mediation and arbitration through MAP/BBB-CARE and other non-

profit organizations. MAP conducted pilot programs in twelve states before announcing the program nationally in October, 1998. During the pilots, participating repair shops demonstrated their adherence to the Pledge and Standards and agreed to follow the UICS in communicating the results of their inspection to their customers. To put some "teeth" in the program, an accreditation requirement for shops was initiated. The requirements are stringent, and a self-policing method has been incorporated which includes the "mystery shopping" of outlets.

We welcome you to join us as we continue our outreach... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site [www.motorist.org](http://www.motorist.org) or contact us at:

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January 1999

## **MAP UNIFORM INSPECTION GENERAL GUIDELINES**

### **OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS**

It is MAP policy that all exhaust, brake, steering, suspension, wheel alignment, drive-line, engine performance and maintenance, and heating, ventilation and air conditioning, and electrical services be offered and performed under the standards and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be "Required" or "Suggested". In addition, suggestions may be made to satisfy the requests expressed by the customer.

When a component is suggested or required to be repaired or replaced, the decision to repair or replace must be made in the customer's best interest, and at his or her choice given the options available.

This section lists the various parts and conditions that indicate a required or suggested service or part replacement. Although this list is extensive, it is not fully inclusive. In addition to this list, a technician may make a suggestion. However, any suggestions must be based on substantial and informed experience, or the vehicle manufacturer's recommended service interval and must be documented.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

#### **Example:**

An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

#### **Example:**

A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's discard specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or addresses a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may be only to suggest service.

Example:

An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.

Example:

The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a repair is required, a MAP shop must refuse partial service on that system if, in the judgment of the service provider, proceeding with the work could create or continue an unsafe condition. When a procedure states that required or suggested repair or replacement is recommended, the customer must be informed of the generally acceptable repair/replacement options whether or not performed by the shop.

When presenting suggested repairs to the customer, you must present the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the MAP Uniform Inspection & Communications Standards that follow:

Reasons to Require Repair or Replacement

- A - Part no longer performs intended purpose
- B - Part does not meet a design specification (regardless of performance)
- C - Part is missing

NOTE: When a repair is required, the shop must refuse partial service to the system in question, if the repair creates or continues an unsafe condition.

Reasons to Suggest Repair or Replacement

- 1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)
- 2 - To address a customer need, convenience, or request (to stiffen ride, enhance performance, eliminate noise, etc.)
- 3 - To comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- 4 - Technician's recommendation based on substantial and informed experience

NOTE: Suggested services are always optional. When presenting suggested repairs to the customer, you must present

the facts, allowing the customer to draw their own conclusions and make an informed decision about how to proceed.

## STEERING AND SUSPENSION

### SERVICE PROCEDURES REQUIRED AND SUGGESTED FOR PROPER VEHICLE OPERATION

Steering and suspension are complex systems made up of a variety of interdependent components. For proper vehicle handling, ride, and tire wear, a thorough inspection is required whenever suspension work is being performed.

Conditions listed assume that the problem has been isolated to the specific component by proper testing procedures.

**NOTE:** When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

**CAUTION:** DO NOT use ride height altering or load compensating components, such as variable rate springs and coil over shocks, on vehicles with height or load sensing proportioning valve-equipped braking systems, unless these components are original equipment.

## AIR RIDE SUSPENSION

**NOTE:** Depending on the air suspension design, there are some aftermarket products available to eliminate the air ride suspension on certain vehicles. If the system has been eliminated with one of these products, then no service is suggested or required.

### AIR RIDE SUSPENSION - AIR SHOCKS AND AIR STRUTS

**NOTE:** This section covers the air spring portion of the air shock or strut. For damping portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

#### AIR RIDE SUSPENSION - AIR SHOCK AND AIR STRUT INSPECTION

Condition	Code	Procedure
Inner fabric of air bag damaged .....	A .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible .....	1 .....	Suggest replacement.

## AIR RIDE SUSPENSION - AIR SPRING VALVES

#### AIR RIDE SUSPENSION - AIR SPRING VALVE INSPECTION

Condition	Code	Procedure
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Attaching hardware incorrect .....	A	.....	Require replacement of incorrect part.
Attaching hardware loose .....	A	...	Require repair or replacement of loose part.
Attaching hardware missing .....	C	..	Require replacement of missing part.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Blocked .....	A	..	Require repair or replacement.
Connector bent .....	A	..	Require repair or replacement.
Connector broken .....	A	.....	Require replacement.
Connector loose .....	A	..	Require repair or replacement.
Inoperative .....	A	..	Require repair or replacement.
Leaking .....	A	..	Require repair or replacement.
Restricted .....	A	..	Require repair or replacement.

## AIR RIDE SUSPENSION - AIR SPRINGS

### AIR RIDE SUSPENSION – AIR SPRING INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Collar cracked .....	A	..... Require replacement.
End cap cracked .....	A	..... Require replacement.
Inner fabric of bag damaged .....	A	..... Require replacement.
Leaking .....	A	.. Require repair or replacement.
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible .....	1	..... Suggest replacement.
Piston cracked .....	A	..... Require replacement.

## AIR RIDE SUSPENSION - COMPRESSORS

### AIR RIDE SUSPENSION - COMPRESSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Connector bent .....	A ..	Require repair or replacement.
Connector broken .....	A .....	Require replacement.
Connector loose .....	A ..	Require repair or replacement.
Does not build pressure .	A .....	(1) Further inspection required.
Excessive run time .....	B .....	(2) Further inspection required.
Inoperative .....	A .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Missing .....	C .....	Require replacement.

(1) - If failure to build pressure is traced to the compressor, require replacement.

(2) - If excessive run time is traced to the compressor, require replacement.

## AIR RIDE SUSPENSION - HEIGHT SENSORS

### AIR RIDE SUSPENSION - HEIGHT SENSOR INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity ....	A .....	Require replacement of corroded part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware		

threads damaged .....	A	...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Dust boot missing .....	2	.....	(1) Suggest replacement.
Dust boot split .....	2	.....	(1) Suggest replacement.
Dust boot torn .....	2	.....	(1) Suggest replacement.
Housing cracked .....	A	.....	Require replacement.
Lead routing incorrect ..	B	..	Require rerouting according to vehicle manufacturer's specifications.
Loose .....	B	...	Require adjustment to vehicle manufacturer's specifications.
Missing .....	C	.....	Require replacement.
Output signal incorrect .	A	..	Require repair or replacement.
Wire lead damaged .....	A	..	Require repair or replacement.

(1) - This condition can lead to damage of the sliding magnet, which, in turn, causes premature sensor failure.

## AIR RIDE SUSPENSION - MODULES

### AIR RIDE SUSPENSION - MODULE INSPECTION

Condition	Code	Procedure
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Housing cracked .....	2	.. Suggest repair or replacement.
Inoperative .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.

## AIR RIDE SUSPENSION - RELAYS (COMPRESSOR)

### AIR RIDE SUSPENSION - RELAY (COMPRESSOR) INSPECTION

Condition	Code	Procedure
Housing cracked .....	2	..... (1) Suggest replacement.
Intermittent .....	A	..... Require replacement.
Missing .....	C	..... Require replacement.
Output signal incorrect .	A	..... Require replacement.

(1) - If moisture enters the relay, it can reduce life expectancy or impair function.

## AIR RIDE SUSPENSION - SWITCHES (ON/OFF)

#### AIR RIDE SUSPENSION - SWITCH (ON/OFF) INSPECTION

Condition	Code	Procedure
Broken .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.
Output signal incorrect .	A .....	Require replacement.

#### AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)

##### AIR RIDE SUSPENSION - TORSION SPRING (COUNTER BALANCING) INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Broken .....	A .....	Require replacement.
Missing .....	C .....	Require replacement.

#### AIR RIDE SUSPENSION - TUBING

##### AIR RIDE SUSPENSION - TUBING INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Blocked .....	A ..	Require repair or replacement.
Fitting incorrect .....	B .....	Require replacement.
Leaking .....	A ..	Require repair or replacement.
Line type incorrect .....	B .....	Require replacement.
Missing .....	C .....	Require replacement.
Restricted .....	A ..	Require repair or replacement.
Routed incorrectly .....	B .....	Require routing correction.

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## AIR RIDE SUSPENSION - WARNING LAMPS

### AIR RIDE SUSPENSION - WARNING LAMP INSPECTION

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Condition	Code	Procedure
Bulb burned out .....	A .....	Require replacement.
Warning light does not come on during bulb check .....	.. .	Further inspection required to determine cause.
Warning light flashes ...	.. .	Further inspection required to determine cause.
Warning light is intermittent .....	.. .	Further inspection required to determine cause.
Warning light stays on after initial bulb check .....	.. .	Further inspection required to determine cause.

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## AIR RIDE SUSPENSION - WIRING HARNESSSES

### AIR RIDE SUSPENSION - WIRING HARNESS INSPECTION

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Condition	Code	Procedure
Connector bent .....	A ..	Require repair or replacement.
Connector broken .....	A ..	Require repair or replacement.
Connector loose .....	A ..	Require repair or replacement.
Damaged (cut, burned, or chafed) .....	A ..	Require repair or replacement.
Excessive resistance ....	B ..	Require repair or replacement.
Fuse blown .....	A .....	Require replacement.
Fusible link blown .....	A .....	Require replacement.
Open .....	A ..	Require repair or replacement.
Poor ground .....	A ..	Require repair or replacement.
Routed incorrectly .....	B ..	Require rerouting according to vehicle manufacturer's specifications.
Shorted .....	A ..	Require repair or replacement.
Terminal bent .....	A ..	Require repair or replacement.
Terminal broken .....	A ..	Require repair or replacement.
Terminal corroded .....	A ..	Require repair or replacement.
Terminal loose .....	A ..	Require repair or replacement.

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## BALL JOINTS

Before requiring or suggesting ball joint replacement, the approved OEM procedure must be used to measure ball joint wear. The measurement(s) obtained, along with the vehicle manufacturer's specifications, must be noted on the inspection report. Some states require that these measurements also appear on the invoice.

**NOTE:** The term "perceptible movement," defined as any visible movement in any direction, has been the industry standard for determining the need for replacement of follower ball joints. Some vehicle manufacturers are now publishing specifications for follower ball joints that were

previously diagnosed by the "perceptible movement" standard. Before requiring or suggesting any parts be replaced based on "perceptible movement," consult your repair manual to determine if OEM specifications exist.

You are not required to replace ball joints in axle sets. However, when replacing a ball joint due to wear exceeding manufacturer's specification, you may suggest replacement of the other ball joint if its measurement shows it is close to the end of its useful life, for preventive maintenance.

#### BALL JOINT INSPECTION

Condition	Code	Procedure
Attaching hardware bent	. B ...	Require repair or replacement of bent part if available; otherwise, replace ball joint.
Attaching hardware broken .....	A ...	Require replacement of broken part if available; otherwise, replace ball joint.
Attaching hardware corroded, affecting structural integrity ...	A .	Require replacement of corroded part if available; otherwise, replace ball joint.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part if available; otherwise, replace ball joint.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part if available; otherwise, replace ball joint.
Attaching hardware missing .....	C ..	Require replacement of missing part if available; otherwise, replace ball joint.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads if available; otherwise, replace ball joint.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads if available; otherwise, replace ball joint.
Binding .....	A .....	(1) Further inspection required.
Grease boot cracked .....	2 .....	(2) Suggest replacement.
Grease boot missing .....	2 .....	(3) Suggest replacement.
Grease boot torn .....	2 .....	(4) Suggest replacement.
Grease fitting broken ...	A ...	Require replacement of grease fitting.
Grease fitting missing ..	C ...	Require replacement of grease fitting.
Grease fitting won't seal .....	A ...	Require replacement of grease fitting.
Greaseable ball joint will		

not take grease .....	2	.....	(5) Suggest replacement of grease fitting.
Nut on ball joint loose .	A	.....	(6) Require repair or replacement.
Pre-load adjustment incorrect .....	B	..	Require repair or replacement.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(7) Require replacement.
Stud broken .....	A	.....	(7) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(7) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - If greaseable, grease ball joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the ball joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the ball joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the ball joint and will accelerate wear.
- (5) - If the greaseable ball joint still will not take grease after replacing the grease fitting, suggest replacement of ball joint.
- (6) - Check for bent stud or damaged taper hole.
- (7) - Check for damaged taper hole.

## BUSHINGS

### BUSHING INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B	... Require repair or replacement of bent part if available; otherwise, replace bushing.
Attaching hardware broken .....	A	... Require replacement of broken part if available; otherwise, replace bushing.
Attaching hardware corroded, affecting structural integrity ...	A	. Require replacement of corroded part if available; otherwise, replace bushing.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part if available; otherwise, replace bushing.
Attaching hardware loose .....	A	... Require repair or replacement of loose part if available; otherwise, replace bushing.
Attaching hardware missing .....	C	.. Require replacement of missing part if available; otherwise, replace bushing.
Attaching hardware threads damaged .....	A	... Require repair or replacement

of part with damaged threads if  
available; otherwise, replace  
bushing.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads if available; otherwise, replace bushing.
Binding .....	A	..	Require repair or replacement.
Deteriorated, affecting performance .....	A	..	Require repair or replacement.
Distorted, affecting performance .....	A	..	Require repair or replacement.
Leaking (fluid-filled type) .....	A	.....	Require replacement.
Missing .....	C	.....	Require replacement.
Noisy .....	2	.....	(1) Further inspection required.
Rubber separating from internal metal sleeve on bonded bushing .....	A	.....	Require replacement.
Seized .....	A	.....	Require replacement.
Shifted (out of position) .....	B	..	Require repair or replacement.
Split .....	A	.....	Require replacement.
Surface cracking (weather- checked) .....	..	.....	No service suggested or required.

(1) - If noise isolated to bushing, suggest repair or  
replacement.

CAUTION: Use only approved lubricant on rubber bushings.  
Petroleum-based lubricants may damage rubber bushings.

## CENTER LINKS

### CENTER LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace center link.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace center link.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace center link.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace center link.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if



			available; otherwise, replace center link.
Bent .....	B .....		Require replacement.
Binding .....	A .....	(1)	Further inspection required.
Grease boot cracked .....	2 .....	(2)	Suggest replacement.
Grease boot missing .....	2 .....	(3)	Suggest replacement.
Grease boot torn .....	2 .....	(4)	Suggest replacement.
Grease fitting broken ...	A ...		Require replacement of grease fitting.
Grease fitting missing ..	C ...		Require replacement of grease fitting.
Grease fitting won't seal .....	A ...		Require replacement of grease fitting.
Grease seal missing .....	2 .....	(3)	Suggest replacement.
Grease seal torn .....	2 .....	(4)	Suggest replacement.
Looseness (perceptible horizontal movement) ...	1 .....	(5)	Suggest replacement.
Looseness that is excessive .....	B .....	(5) (6)	Require replacement.
Seized .....	A .....		Require replacement.
Stud bent .....	B .....	(7)	Require replacement.
Stud broken .....	A .....	(7)	Require replacement.
Stud loose in taper hole .....	A .....	(7)	Require repair or replacement.
Taper hole elongated ....	A .....	(8)	Require replacement.
Threads damaged .....	A ..		Require repair or replacement.
Threads stripped (threads missing) .....	A .....	(7)	Require replacement.
Wear exceeds manufacturer's specifications .....	B .....		Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (7) - Check for damaged taper hole.
- (8) - Check for damaged stud.

## CONTROL ARM SHAFTS

### CONTROL ARM SHAFT INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require replacement of broken

				part, if available; otherwise, replace shaft.
Attaching hardware loose .....	A	...	Require repair or replacement of loose part, if available; otherwise, replace shaft.	
Attaching hardware missing .....	C	..	Require replacement of missing part, if available; otherwise, replace shaft.	
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace shaft.	
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace shaft.	
Bent .....	B	.....	Require replacement.	
Shaft bushing surface undersized (worn) .....	B	.....	Require replacement.	
Threads damaged .....	A	..	Require repair or replacement.	
Threads stripped (threads missing) .....	A	.....	Require replacement.	

## CONTROL ARMS

### CONTROL ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B	... Require repair or replacement of bent part, if available; otherwise, replace control arm.
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace control arm.
Attaching hardware corroded, affecting structural integrity ...	A	. Require replacement of corroded part, if available; otherwise, replace control arm.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace control arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace control arm.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace control arm.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads,

if available; otherwise,  
replace control arm.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace control arm.
Bent .....	B	.....	Require replacement.
Bushing hole oversized ..	B	.....	Require replacement.
Ball joint hole oversized (loose interference or press fit) .....	B	.....	(1) Further inspection required.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - If oversized ball joint is available, require  
replacement of ball joint. If oversized ball joint  
is not available, require replacement of control arm.

## DRAG LINKS

### DRAG LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace drag link.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace drag link.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace drag link.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace drag link.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace drag link.
Bent .....	B	..... Require replacement.
Binding .....	A	..... (1) Further inspection required.
Grease boot cracked .....	2	..... (2) Suggest replacement.
Grease boot missing .....	2	..... (3) Suggest replacement.
Grease boot torn .....	2	..... (4) Suggest replacement.
Grease fitting broken ...	A	... Require replacement of grease fitting.

Grease fitting missing ..	C	...	Require replacement of grease fitting.
Grease fitting won't seal .....	A	...	Require replacement of grease fitting.
Grease seal missing .....	2	.....	(5) Suggest replacement.
Grease seal torn .....	2	.....	(4) Suggest replacement.
Looseness (perceptible horizontal movement) ...	1	.....	(6) Suggest replacement.
Looseness that is excessive .....	B	.....	(6) (7) Require replacement.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(8) Require replacement.
Stud broken .....	A	.....	(8) Require replacement.
Stud loose in taper hole .....	A	.....	(8) Require repair or replacement.
Taper hole elongated ....	A	.....	(9) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(8) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - Missing grease seal will allow contaminants to enter the joint and will accelerate wear.
- (6) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (7) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (8) - Check for damaged taper hole.
- (9) - Check for damaged stud.

## ELECTRONIC RIDE CONTROL SHOCKS AND STRUTS

NOTE: This section covers the electronic damping control portion of the electronic shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES section.

### ELECTRONIC RIDE CONTROL SHOCK AND STRUT INSPECTION

Condition	Code	Procedure
Connector bent .....	A ..	Require repair or replacement.
Connector broken .....	A ..	Require repair or replacement.
Connector loose .....	A ..	Require repair or replacement.
Electronic valve control		

inoperative .....	2	.....	(1) Suggest replacement.
Terminal bent .....	A	..	Require repair or replacement.
Terminal broken .....	A	..	Require repair or replacement.
Terminal corroded .....	A	..	Require repair or replacement.
Terminal loose .....	A	..	Require repair or replacement.

(1) - It is acceptable to replace with a non-electronically controlled unit, where available.

## IDLER ARMS

### IDLER ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace idler arm.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace idler arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace idler arm.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace idler arm.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace idler arm.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace idler arm.
Binding .....	A	..... (1) Further inspection required.
Grease boot cracked .....	2	..... (2) Suggest replacement.
Grease boot missing .....	2	..... (3) Suggest replacement.
Grease boot torn .....	2	..... (4) Suggest replacement.
Grease fitting broken ...	A	... Require replacement of grease fitting.
Grease fitting missing ..	C	... Require replacement of grease fitting.
Grease fitting won't seal .....	A	... Require replacement of grease fitting.
Grease seal missing .....	2	..... (5) Suggest replacement.
Grease seal torn .....	2	..... (4) Suggest replacement.
Greaseable joint will not take grease .....	2	..... (1) Suggest replacement of grease fitting.
Looseness at frame bracket end .....	B	..... (6) (7) Require repair or replacement.

Looseness at link end (perceptible horizontal movement) .....	1	.....	(8) Suggest replacement.
Looseness at link end that is excessive .....	B	.....	(8) (9) Require replacement.
Mounted out of position (center link not parallel) .....	B	.....	Require repositioning.
Nut on stud loose .....	A	.....	(10) Require repair or replacement.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(11) Require replacement.
Stud broken .....	A	.....	(11) Require replacement.
Taper hole elongated ....	A	.....	(12) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(11) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (5) - Missing grease seal will allow contaminants to enter joint and will accelerate wear.
- (6) - If manufacturer's procedures and specifications exist, use those procedures and specifications; otherwise, use an approved inspection method such as the dry park check.
- (7) - Looseness is defined as movement that creates excessive toe change.
- (8) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

- CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
- (9) - Excessive looseness is defined as significant enough to affect vehicle handling or structural integrity.
  - (10) - Check for bent stud or damaged taper hole.
  - (11) - Check for damaged taper hole.
  - (12) - Check for damaged stud.

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## KING PINS

You are not required to replace king pins in axle sets. However, when replacing a king pin due to wear exceeding manufacturer's specifications, you may suggest replacement of the other king pin on the axle if its measurement shows it is close to the end of its useful life.

### KING PIN INSPECTION

Condition	Code	Procedure
Bearing balls pitted ....	A	..... Require replacement.
Bearing balls worn .....	A	..... Require replacement.
Bearing races pitted ....	A	..... Require replacement.

Bearing races worn .....	A	.....	Require replacement.
Bearing rollers pitted ..	A	.....	Require replacement.
Bearing rollers worn ....	A	.....	Require replacement.
Bearing seal bent .....	2	.	Suggest replacement of seal or bearing.
Bearing seal missing ....	2	.	Suggest replacement of seal or bearing.
Bearing seal torn .....	2	.	Suggest replacement of seal or bearing.
Binding .....	A	..	Require repair or replacement of affected parts.
End caps missing .....	C	.	Require replacement of missing part, if available; otherwise, replace king pin.
End play exceeds specifications .....	B	.....	Require repair.
Grease fitting broken ...	A	..	Require replacement of grease fitting.
Grease fitting missing ..	C	..	Require replacement of grease fitting.
Grease fitting won't seal .....	A	..	Require replacement of grease fitting.
Locating pins missing ...	C	.	Require replacement of missing part, if available; otherwise, replace king pin.
Looseness exceeds manufacturer's specifications .....	B	....	Require replacement of worn parts.
Seized .....	A	.....	Require replacement.
Threads damaged .....	A	.	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.
Will not take grease ....	2	.....	(1) Suggest replacement of grease fitting.

(1) - If king pin will not take grease after replacement of grease fitting, suggest replacement of king pin.

## PITMAN ARMS

### PITMAN ARM INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace pitman arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace pitman arm.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace pitman arm.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise,

replace pitman arm.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace pitman arm.
Bent .....	B	.....	Require replacement.
Binding .....	A	.....	(1) Further inspection required.
Grease boot cracked .....	2	.....	(2) Suggest replacement.
Grease boot missing .....	2	.....	(3) Suggest replacement.
Grease boot torn .....	2	.....	(4) Suggest replacement.
Grease fitting broken ...	A	.....	Require replacement grease fitting.
Grease fitting missing ..	C	...	Require replacement of grease fitting.
Grease fitting won't seal .....	A	...	Require replacement of grease fitting.
Grease seal missing .....	2	.....	(3) Suggest replacement of seal.
Grease seal torn .....	2	.....	(4) Suggest replacement of seal.
Looseness (perceptible horizontal movement) ...	1	.....	(5) Suggest replacement.
Looseness that is excessive .....	B	.....	(5) (6) Require replacement.
Nut on stud loose .....	A	.....	(7) Require repair or replacement.
Seized .....	A	.....	Require replacement.
Splines damaged .....	A	..	Require repair or replacement.
Splines stripped (splines missing) .....	A	.....	Require replacement.
Stud bent .....	B	.....	(8) Require replacement.
Stud broken .....	A	.....	(8) Require replacement.
Stud loose in taper hole .....	A	.....	(8) Require repair or replacement.
Taper hole elongated ....	A	.....	(9) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(8) Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
  - (7) - Check for bent stud of damaged taper hole.
  - (8) - Check for damaged taper hole.
  - (9) - Check for damaged stud.
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## POWER STEERING HOSES

### POWER STEERING HOSE INSPECTION

Condition	Code	Procedure
Blistered .....	B	..... Require replacement.
Blocked .....	A	. Require repair or replacement.
Fitting threads damaged .	A	. Require repair or replacement.
Fitting threads stripped (threads missing) .....	A	..... Require replacement.
Inner fabric (webbing) cut .....	A	..... Require replacement.
Leaking .....	A	. Require repair or replacement.
Missing .....	C	..... Require replacement.
Outer covering is cracked to the extent that the inner fabric of hose is visible .....	B	..... Require replacement.
Restricted .....	A	. Require repair or replacement.

## POWER STEERING (HYDRAULIC) PUMPS

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

### POWER STEERING (HYDRAULIC) PUMP INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B	... Require repair or replacement of bent part.
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Belt alignment incorrect .....	B	..... (1) Further inspection required.
Belt cracked .....	1	..... Suggest replacement.
Belt frayed .....	1	..... Suggest replacement.
Belt missing .....	C	..... Require replacement.
Belt noisy .....	2	..... (2) Further inspection required.
Belt plies separated ....	A	..... Require replacement.

Belt tension out of specification .....	B	.....	Require adjustment or replacement.
Belt worn beyond adjustment range .....	B	.....	Require replacement.
Belt worn so it contacts bottom of pulley .....	A	.....	Require replacement.
Binding .....	A	..	Require repair or replacement.
Fluid at or beyond service interval .....	3	.....	Suggest fluid change.
Fluid contaminated .....	B	.....	(3) Require flushing and refilling of the system.
Fluid level incorrect ...	B	.....	Require adjustment of fluid level.
Inadequate assist .....	A	.....	(4) Further inspection required.
Leaking .....	A	..	Require repair or replacement.
Noise .....	2	.....	(5) Further inspection required.
Pulley bent .....	A	...	Require repair or replacement of pulley.
Pulley missing .....	C	..	Require replacement of pulley.
Remote reservoir leaking .....	A	.....	Require replacement of reservoir,
Reservoir cap broken ....	A	.....	Require replacement of cap.
Reservoir cap missing ...	C	.....	Require replacement of cap.
Seized .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

- (1) - Determine cause of incorrect alignment and require repair.  
(2) - Determine cause of noise and suggest repair.  
(3) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.  
(4) - If pump is source of inadequate assist, require repair or replacement.  
(5) - If noise is isolated to pump, suggest repair or replacement.

## RADIUS ARMS

### RADIUS ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Bent .....	B	.....	Require replacement.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

## RELAY RODS

### RELAY ROD INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace relay rod.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace relay rod.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace relay rod.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace relay rod.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace relay rod.
Bent .....	B	..... Require replacement.
Binding .....	A	..... (1) Further inspection required.
Grease boot cracked .....	2	..... (2) Suggest replacement.
Grease boot missing .....	2	..... (3) Suggest replacement.
Grease boot torn .....	2	..... (4) Suggest replacement.
Grease fitting broken ...	A	..... Require replacement grease fitting.
Grease fitting missing ..	C	... Require replacement of grease fitting.
Grease fitting won't seal .....	A	... Require replacement of grease fitting.
Grease seal missing .....	2	..... (3) Suggest replacement.
Grease seal torn .....	2	..... (4) Suggest replacement.
Looseness (perceptible horizontal movement) ...	1	..... (5) Suggest replacement.
Looseness that is excessive .....	B	..... (5) (6) Require replacement.
Seized .....	A	..... Require replacement.
Stud bent .....	B	..... (7) Require replacement.

Stud loose in taper hole .....	A .....	(7) Require repair or replacement.
Taper hole elongated ....	A .....	(8) Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	(7) Require replacement.
Wear exceeds manufacturer's specifications .....	B .....	Require replacement.

- (1) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (3) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (6) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (7) - Check for damaged taper hole.
- (8) - Check for damaged stud.

## SHOCK ABSORBERS, STRUT CARTRIDGES AND STRUT ASSEMBLIES

You are not required to replace shocks or struts in axle sets. However, when replacing a shock or strut due to the conditions that follow, you may suggest replacement of the other shock or strut on the same axle for improved performance and preventive maintenance.

- \* Part is close to the end of its useful life
- \* To extend tire life
- \* To balance ride and handling
- \* To improve stopping distance

When replacing steering and/or suspension components which may affect an alignment angle, you are required to check and adjust alignment as needed. Refer to the OEM specifications.

Under no circumstances should a technician bend struts or strut housings.

A vehicle's load-carrying and handling abilities are limited by its suspension, tires, brakes, and driveline. Installing coil over shocks or any other load assist device does not increase the vehicle's load capacity. See the vehicle owner's manual for more details.

NOTE: If vehicle is equipped with original equipment coil over shocks, apply the conditions for coil springs from the SPRINGS - COIL, LEAF AND TORSION BAR section of the STEERING AND SUSPENSION guidelines. If the vehicle is equipped with add-on coil over shocks, you may suggest replacing the shocks with standard shocks for any spring-related condition.

## SHOCK ABSORBER, STRUT CARTRIDGE AND STRUT ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part, if available; otherwise, replace shock or strut.
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise, replace shock or strut.
Attaching hardware corroded, affecting structural integrity ...	A .	Require replacement of corroded part, if available; otherwise, replace shock or strut.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part, if available; otherwise, replace shock or strut.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace shock or strut.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace shock or strut.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads, if available; otherwise, replace shock or strut.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads, if available; otherwise, replace shock or strut.
Binding .....	A .....	Require replacement.
Body dented .....	A .....	(1) Further inspection required.
Body punctured .....	A .....	Require replacement.
Brake hose bracket bent .....	B ..	Require repair or replacement.
Brake hose bracket missing .....	C .....	Require replacement.
Brake hose bracket threads damaged .....	A ..	Require repair or replacement.
Brake hose bracket threads stripped (threads missing) .....	C .....	Require replacement.
Compression bumper missing .....	C .....	Require replacement of compression bumper.
Compression bumper split .....	1 .....	Suggest replacement of compression bumper.
Damping (none) .....	A .....	Require replacement.
Dust boot (bellows) split .....	2 .....	(2) Suggest replacement of boot.

Dust boot (bellows) missing .....	2	..... (2) Suggest replacement of boot.
Dust boot (bellows) torn .....	2	..... (2) Suggest replacement of boot.
Dust shield broken .....	2	..... (2) Suggest replacement.
Dust shield missing .....	2	..... (2) Suggest replacement.
Gland nut (strut housing cap) is not removable using appropriate tool .	A	.. (3) Require replacement of nut and/or housing.
Gland nut (strut housing cap) threads damaged ...	A	... Require repair or replacement of nut.
Gland nut (strut housing cap) threads stripped (threads missing) .....	A	..... Require replacement of nut.
Housing dented .....	A	..... (1) Further inspection required.
Housing punctured .....	A	..... Require replacement.
Jounce bumper missing ...	C	... Require replacement of jounce bumper.
Jounce bumper split .....	1	... Suggest replacement of jounce bumper.
Leaking oil, enough for fluid to be running down the body .....	A	..... (4) Require replacement.
Noise .....	2	..... (5) Further inspection required.
Piston rod bent .....	A	..... Require replacement.
Piston rod broken .....	A	..... Require replacement.
Piston rod has surface defect .....	2	..... Suggest replacement.
Piston rod threads damaged .....	A	.. Require repair or replacement.
Piston rod threads stripped (threads missing) .....	A	..... Require replacement.
Seized .....	A	..... Require replacement.
Shock missing .....	C	..... Require replacement.
Strut housing bent .....	A	..... Require replacement.
Strut housing cap (gland nut) is not removable using appropriate tool .	A	..... (3) Require replacement of nut and/or housing.
Strut housing cap (gland nut) threads damaged ...	A	... Require repair or replacement of nut.
Strut housing cap (gland nut) threads stripped (threads missing) .....	A	..... Require replacement of nut.
Strut housing severely corroded, affecting structural integrity ...	A	..... Require replacement.
Strut housing threads damaged .....	A	.. Require repair or replacement.
Strut housing threads stripped (threads missing) .....	A	..... Require replacement.
Tire cupping .....	A	..... (6) Further inspection required.

- (1) - Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.
- (2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
- (3) - Only required if replacing cartridge.
- (4) - CAUTION: If the strut cartridge has been replaced previously, the oil on the strut housing may be filler oil. The technician must identify the source of the oil.
- (5) - If noise is isolated to shock or strut, suggest replacement.
- (6) - Although shocks or struts may have contributed to tire cupping, an inspection is needed of the entire suspension system. If the shock or strut is found to be contributing to the tire cupping, require replacement.

## SPINDLES

### SPINDLE INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Bent .....	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Race seat area		
undersized .....	B .....	Require replacement.
Scored .....	A ..	Require repair or replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## SPRINGS - COIL, LEAF AND TORSION BAR

When springs are replaced, it is suggested, but not required, that both springs on an axle be replaced to maintain equal height from side to side and to provide a balanced ride and proper handling.

When variable rate springs are installed in place of conventional coil springs, they must be installed in axle sets to ensure proper handling, uniform ride, and proper chassis height.

Erroneous height measurements may result from: improper tire inflation, non-standard tire or wheel size, and heavy load in vehicle or trunk.

### SPRING (COIL, LEAF AND TORSION BAR) INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B ....	Require repair or replacement of bent part.
Attaching hardware broken .....	A ....	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity ..	A ..	Require replacement of corroded part.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ....	Require repair or replacement of loose part.
Attaching hardware missing .....	C ...	Require replacement of missing part.
Attaching hardware threads damaged .....	A ....	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Broken (all springs except secondary leave(s) on multi-leaf springs) .....	A .....	Require replacement.
Coil clash .....	.. ..	(1) Require ride height check.
Coil spring insulator deteriorated .....	2 .....	Suggest replacement of insulator.
Coil spring insulator missing .....	2 .....	Suggest replacement of insulator.
Coil spring insulator split .....	2 .....	Suggest replacement of insulator.
Coil spring plastic coating deteriorated - rust present .....	A .....	(2) Refer to manufacturer's service requirements.
Composite spring damaged .....	.. ..	(3) Further inspection required.
Cracked (all springs except composite leaf and secondary leave(s) on multi-leaf springs) ...	A .....	Require replacement.
Installed incorrectly ..	B .....	Require repair.
Leaf spring insulators missing .....	2 .....	Suggest replacement of insulators.
Secondary leaf on multi-leaf spring broken ....	1 ....	Suggest repair or replacement
Secondary leaf on multi-leaf spring cracked ...	1 ....	Suggest repair or replacement
Torsion bar		



adjuster bent .....	A .....	(4) Require repair or replacement of adjuster.
Torsion bar adjuster seized .....	A ....	(4) Require repair or replacement of adjuster.
Torsion bar adjuster threads damaged .....	A ....	(4) Require repair or replacement of part with damaged threads.
Torsion bar adjuster threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Vehicle suspension height not within OEM specifications .....	B .....	Require adjustment or replacement.

- (1) - If vehicle is within manufacturer's height specifications, no service is suggested or required.
- (2) - Some manufacturers require replacement under these conditions.
- (3) - Check vehicle ride height. If ride height is OK, no service is suggested or required.
- (4) - Only required if ride height needs to be adjusted.

## STEEL POWER STEERING LINES

**CAUTION:** When replacing steel power steering lines, be sure to use a replacement product that meets or exceeds OEM design specifications.

### STEEL POWER STEERING LINE INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Blocked .....	A ..	Require repair or replacement.
Fitting incorrect (such as compression fitting) .....	B .....	Require replacement.
Flare type incorrect ....	B .....	Required replacement.
Leaking .....	A .....	Require tightening or replacement.
Line type incorrect .....	B .....	Require replacement.

Restricted .....	A .....	Require replacement.
Routed incorrectly .....	B .....	Require routing correction.
Rust-pitted .....	1 .....	Suggest replacement.
Rust pitted, affecting structural integrity ..	A .....	Require replacement.

## STEERING ARMS

### STEERING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B ...	Require repair or replacement of bent part.
Attaching hardware broken .....	A ...	Require replacement of broken part.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C ..	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Bent .....	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Taper hole elongated ....	A .....	(1) Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

(1) - Check for damaged stud.

## STEERING DAMPERS

The following procedures are only required if the vehicle was originally equipped from the factory with a steering damper. If the steering damper is an add-on unit, then the unit may be removed instead of repairing or replacing.

### STEERING DAMPER INSPECTION

Condition	Code	Procedure
Attaching hardware bent .	B ...	Require repair or replacement of bent part, if available; otherwise, replace steering damper.
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise,

replace steering damper.

Attaching hardware corroded, affecting structural integrity ...	A	.	Require replacement of corroded part, if available; otherwise, replace steering damper.
Attaching hardware incorrect .....	A	.....	Require replacement of incorrect part, if available; otherwise, replace steering damper.
Attaching hardware loose .....	A	...	Require repair or replacement of loose part, if available; otherwise, replace steering damper.
Attaching hardware missing .....	C	..	Require replacement of missing part, if available; otherwise, replace steering damper.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace steering damper.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace steering damper.
Binding .....	A	.....	Require replacement.
Damper body dented .....	A	.....	(1) Further inspection required.
Damper body punctured ...	A	.....	Require replacement.
Damping (none) .....	A	.....	Require replacement.
Dust boot (bellows) missing .....	2	.....	(2) Suggest replacement of boot.
Dust boot (bellows) split .....	2	.....	(2) Suggest replacement of boot.
Dust shield broken .....	2	.....	(2) Suggest replacement.
Dust shield missing .....	2	.....	(2) Suggest replacement.
Leaking oil, enough for fluid to be running down the body .....	A	.....	Require replacement.
Loose .....	A	..	Require repair or replacement.
Missing .....	C	.....	Require replacement.
Noise .....	2	.....	(3) Further inspection required.
Piston rod bent .....	A	.....	Require replacement.
Piston rod broken .....	A	.....	Require replacement.
Piston rod has surface defect .....	2	.....	Suggest replacement.
Piston rod threads stripped (threads missing) .....	A	.....	Require replacement.
Piston rod threads damaged .....	A	..	Require repair or replacement.
Seized .....	A	.....	Require replacement.

(1) - Require replacement of units where dents restrict damper

piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube dampers.

- (2) - This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
- (3) - If noise is isolated to damper, suggest replacement.

## STEERING GEARS (EXCEPT RACK AND PINION)

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

### STEERING GEAR (EXCEPT RACK AND PINION) INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ..	Require replacement of broken part.
Attaching hardware loose .....	A ..	Require repair or replacement of loose part.
Attaching hardware missing .....	C .....	Require replacement of missing part.
Attaching hardware threads damaged .....	A ..	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A ....	Require replacement of part with stripped threads.
Binding .....	A ...	Require repair or replacement
Flex coupler binding ....	A ...	Require repair or replacement of coupler.
Flex coupler loose .....	A ...	Require repair or replacement of coupler.
Flex coupler missing parts .....	A ...	Require repair or replacement of coupler.
Flex coupler soft/spongy .....	A .	Require replacement of coupler.
Flex coupler torn .....	A .	Require replacement of coupler.
Fluid contaminated .....	B .....	(1) Require flushing and refilling of the system.
Gasket leaking .....	A ...	Require repair or replacement of gasket.
Housing leaking .....	A .....	Require replacement.
Hydraulic fittings leaking .....	A ...	Require repair or replacement of fittings.
Inadequate power assist .	A .....	(2) Further inspection required. See note below.
Lash exceeds manufacturer's specifications .....	B ..	Require repair or replacement.
Seal leaking .....	A ...	Require repair or replacement

Splines damaged	.....	A	... of seal and/or mating part. Require repair or replacement of splines.
Splines stripped	.....	A	. Require replacement of splines.
Steering coupler shield cracked	.....	2	..... Suggest replacement.
Steering coupler shield missing	.....	C	..... Require replacement.
Threads damaged	.....	A	... Require repair or replacement of part with damaged threads.
Threads stripped (threads missing)	.....	A	..... Require replacement of part with stripped threads.
U-joint binding	.....	A	... Require repair or replacement of joint.
U-joint loose	.....	A	... Require repair or replacement of joint.
Unequal power assist	....	A	.. Require repair or replacement.
(1) - Determine and correct source of contamination. OEM specifications must be followed for fluid type.			
(2) - If steering gear is source of inadequate assist, require repair or replacement.			

## STEERING GEARS - RACK AND PINION

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

### STEERING GEARS - RACK AND PINION INSPECTION

Condition	Code	Procedure
Attaching hardware broken	..... A	..... Require replacement of broken part.
Attaching hardware loose	..... A	.. Require repair or replacement of loose part.
Attaching hardware missing	..... C	..... Require replacement of missing part.
Attaching hardware threads damaged	..... A	.. Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	..... A	.... Require replacement of part with stripped threads.
Balance tube blocked	.... A	.. Require repair or replacement of balance tube.
Balance tube missing	.... C	.. Require replacement of balance tube.
Balance tube restricted	. A	... Require repair or replacement of balance tube.
Bellows boot clamp missing	..... C	... Require replacement of clamp.
Bellows boot cracked		

(not through) .....	2	..	Suggest replacement of bellows boot.
Bellows boot missing ....	C	..	Require replacement of bellows boot.
Bellows boot not sealing .....	A	...	Require repair or replacement of bellows boot.
Bellows boot torn .....	A	..	Require replacement of bellows boot.
Bellows boot twisted (from toe adjustment) ..	B	.....	Require repair.
Fitting leaking .....	A	..	Require repair or replacement.
Fitting missing .....	A	.	Require replacement of fitting.
Fitting threads damaged .....	A	...	Require repair or replacement of part with damaged threads.
Fitting threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
Flex coupler binding ....	A	...	Require repair or replacement of coupler.
Flex coupler loose .....	A	...	Require repair or replacement of coupler.
Flex coupler missing parts .....	A	...	Require repair or replacement of coupler.
Flex coupler soft/spongy .....	A	.	Require replacement of coupler.
Flex coupler torn .....	A	.	Require replacement of coupler.
Fluid contaminated .....	B	.....	(1) Require flushing and refilling of the system.
Gasket leaking .....	A	..	Require repair or replacement.
Hard steering on cold start-up .....	1	.....	(2) Suggest repair or replacement.
Housing cracked, affecting structural integrity .....	B	.....	Require replacement.
Housing leaking .....	A	.....	Require replacement.
Inadequate power assist .	A	.....	(3) Further inspection required.
Lash exceeds manufacturer's specifications .....	B	..	Require repair or replacement.
Seal leaking .....	A	..	Require repair or replacement.
Splines damaged .....	A	..	Require repair or replacement.
Splines stripped (splines missing) .....	A	.....	Require replacement.
Steel line blocked .....	A	...	Require repair or replacement of line.
Steel line leaking .....	A	...	Require repair or replacement of line.
Steel line missing .....	C	....	Require replacement of line.
Steel line restricted ...	A	...	Require repair or replacement of line.
Steering coupler shield cracked .....	2	.....	Suggest replacement.
Steering coupler shield missing .....	C	.....	Require replacement.
Steering coupler shield torn .....	2	.....	Suggest replacement.
Threads damaged .....	A	...	Require repair or replacement of part with damaged threads.

Threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads.
U-joint binding .....	A	...	Require repair or replacement of joint.
U-joint loose .....	A	...	Require repair or replacement of joint.
Unequal power assist ....	A	..	Require repair or replacement.

- (1) - Determine and correct source of contamination. Follow OE specifications for fluid type.  
(2) - Indicates internal wear.  
(3) - If steering gear is source of inadequate assist, require repair or replacement.

## STEERING KNUCKLES

### STEERING KNUCKLE INSPECTION

Condition	Code	Procedure
Attaching hardware bent .....	B	... Require repair or replacement of bent part.
Attaching hardware broken .....	A	... Require replacement of broken part.
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part.
Attaching hardware loose .....	A	... Require repair or replacement of loose part.
Attaching hardware missing .....	C	.. Require replacement of missing part.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads.
Bent .....	B	..... Require replacement.
Broken .....	A	..... Require replacement.
Pinch bolt incorrect ....	B	... Require replacement with bolt that meets OE design.
Pinch bolt loose .....	B	..... Require repair.
Pinch bolt missing .....	B	..... Require replacement.
Pinch bolt tabs deformed (pinched together), .032" or more before clamping .....	B	..... (1) Require replacement.
Taper hole elongated ....	A	..... (2) Require replacement.
Threads damaged .....	A	.. Require repair or replacement.
Threads stripped (threads missing) .....	A	.. Require repair or replacement.

- (1) - Steering knuckle deformation can cause pinch  
bolt breakage.  
(2) - Check for damaged stud.

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## STRIKE OUT BUMPERS

### STRIKE OUT BUMPER INSPECTION

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Condition	Code	Procedure
Attaching hardware broken .....	A .....	Require replacement of broken part.
Attaching hardware corroded, affecting structural integrity ...	A .....	Require replacement of corroded part.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part.
Attaching hardware missing .....	C .....	Require replacement of missing part.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads.
Missing .....	C .....	Require replacement.
Split .....	1 .....	Suggest replacement.

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## STRUT RODS

### STRUT ROD INSPECTION

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Condition	Code	Procedure
Adjusting nut seized ....	A .....	(1) Require repair or replacement.
Attaching hardware bent .....	B ...	Require repair or replacement of bent part, if available; otherwise, replace strut rod.
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise, replace strut rod.
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part, if available; otherwise, replace strut rod.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace strut rod.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace strut rod.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads,



if available; otherwise,  
replace strut rod.

Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace strut rod.
Attaching (mating) hole oversized .....	A	...	Require repair or replacement of frame.
Attaching point on frame corroded, affecting structural integrity ...	A	.....	Require repair of frame.
Bent .....	A	.....	Require replacement.
Mating (attaching) hole oversized .....	A	...	Require repair or replacement of frame.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

(1) - Only required if an alignment is being performed.

## STRUT UPPER BEARING PLATE ASSEMBLIES

NOTE: When the following guidelines indicate replacement of bearing, only the bearing should be replaced if it is available separately; otherwise, replace the bearing plate assembly.

### STRUT UPPER BEARING PLATE ASSEMBLY INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace bearing plate assembly.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace bearing plate assembly.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace bearing plate assembly.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace bearing plate assembly.
Bearing axial or radial movement exceeds vehicle manufacturer's		

specifications .....	B	.....	Require replacement of bearing.
Bearing binding .....	A	.....	Require replacement of bearing.
Bearing missing .....	C	.....	Require replacement of bearing.
Bearing seized .....	A	.....	Require replacement of bearing.
Bent .....	B	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Missing .....	C	.....	Require replacement.
Severely corroded, affecting structural integrity .....	A	.....	Require replacement.

## SWAY BAR LINKS

### SWAY BAR LINK INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace link.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace link.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace link.
Attaching hardware threads damaged .....	A	... Require repair or replacement of part with damaged threads, if available; otherwise, replace link.
Attaching hardware threads stripped (threads missing) .....	A	..... Require replacement of part with stripped threads, if available; otherwise, replace link.
Ball and socket has looseness (perceptible vertical movement) .....	1	..... (1) Suggest replacement.
Ball and socket has looseness that is excessive .....	B	..... (1)(2) Require replacement.
Bent .....	B	..... Require replacement.
Broken .....	A	..... Require replacement.
Corroded, affecting structural integrity ...	A	..... Require replacement.
Grease boot cracked .....	2	..... (3) Suggest replacement.
Grease boot missing .....	2	..... (4) Suggest replacement.
Grease boot torn .....	2	..... (5) Suggest replacement.
Missing .....	C	..... Require replacement.
Nut on stud loose .....	A	..... (6) Require repair.
Stud bent .....	B	..... (7) Require replacement.
Stud broken .....	A	..... (7) Require replacement.
Threads damaged .....	A	.. Require repair or replacement.

Threads stripped (threads missing) ..... A ..... (7) Require replacement.

- (1) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (2) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (3) - Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) - Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) - Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (6) - Check for bent stud or damaged taper hole.
- (7) - Check for damaged taper hole.

## SWAY BARS

### SWAY BAR INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A ...	Require replacement of broken part, if available; otherwise, replace sway bar.
Attaching hardware corroded, affecting structural integrity ...	A .....	Require replacement of corroded part, if available; otherwise, replace sway bar.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace sway bar.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace sway bar.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads, if available; otherwise, replace sway bar.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads, if available; otherwise, replace sway bar.
Bent .....	B .....	Require replacement.
Broken .....	A .....	Require replacement.
Threads damaged .....	A ..	Require repair or replacement.
Threads stripped (threads missing) .....	A .....	Require replacement.

## TIE ROD ENDS (INNER AND OUTER)

## TIE ROD END (INNER AND OUTER) INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A .....	Require replacement of incorrect part, if available; otherwise, replace tie rod end.
Attaching hardware loose .....	A ...	Require repair or replacement of loose part, if available; otherwise, replace tie rod end.
Attaching hardware missing .....	C ..	Require replacement of missing part, if available; otherwise, replace tie rod end.
Attaching hardware threads damaged .....	A ...	Require repair or replacement of part with damaged threads, if available; otherwise, replace tie rod end.
Attaching hardware threads stripped (threads missing) .....	A .....	Require replacement of part with stripped threads, if available; otherwise, replace tie rod end.
Adjusting sleeve bent ...	B ...	Require replacement of sleeve or tie rod end.
Adjusting sleeve clamps out of position .....	B .....	Require repair.
Adjusting sleeve corroded, affecting structural integrity ...	A ...	Require replacement of sleeve or tie rod end.
Adjusting sleeve missing .....	C ...	Require replacement of sleeve or tie rod end.
Adjusting sleeve seized .....	A .....	(1) Require repair or replacement.
Adjusting sleeve threads damaged .....	A ...	Require repair or replacement of sleeve or tie rod end.
Adjusting sleeve threads stripped (threads missing) .....	A ...	Require replacement of sleeve or tie rod end.
Binding .....	A .....	(2) Further inspection required.
Grease boot cracked .....	2 .....	(3) Suggest replacement.
Grease boot missing .....	2 .....	(4) Suggest replacement.
Grease boot torn .....	2 .....	(5) Suggest replacement.
Grease fitting broken ...	A ...	Require replacement of grease fitting.
Grease fitting missing ..	C ...	Require replacement of grease fitting.
Grease fitting won't seal .....	A ...	Require replacement of grease fitting.
Grease seal missing .....	2 .....	(4) Suggest replacement of seal.

Grease seal torn .....	2	.....	(5) Suggest replacement of seal.
Greaseable tie rod end won't take grease .....	2	.....	(6) Suggest replacement of grease fitting.
Looseness (perceptible horizontal movement) ...	1	.....	(7) Suggest replacement.
Looseness exceeds manufacturer's specifications .....	B	.....	Require replacement.
Looseness that is excessive .....	B	.....	(7)(8) Require replacement.
Nut on stud loose .....	A	.....	(9) Require repair or replacement of nut.
Seized .....	A	.....	Require replacement
Stud bent .....	B	.....	(10) Require replacement.
Stud broken .....	A	.....	(10) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(10) Require replacement.

- (1) - Only required if toe needs to be adjusted.
  - (2) - If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
  - (3) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
  - (4) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
  - (5) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
  - (6) - If greaseable tie rod end will not take grease after replacing the grease fitting, suggest replacement of tie rod end.
  - (7) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
- CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.
- (8) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
  - (9) - Check for bent stud or damaged taper hole.
  - (10) - Check for damaged taper hole.

## TRACK BARS

### TRACK BAR INSPECTION

Condition	Code	Procedure
Attaching hardware incorrect .....	A	..... Require replacement of incorrect part, if available; otherwise, replace track bar.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available; otherwise, replace track bar.
Attaching hardware missing .....	C	.. Require replacement of missing part, if available; otherwise, replace track bar.
Attaching hardware		

threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace track bar.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace track bar.
Bent .....	B	.....	Require replacement.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Grease boot cracked .....	2	.....	(1) Suggest replacement.
Grease boot missing .....	2	.....	(2) Suggest replacement.
Grease boot torn .....	2	.....	(3) Suggest replacement.
Holes distorted .....	A	.....	Require replacement.
Looseness (perceptible horizontal movement) ...	1	.....	(4) Suggest replacement.
Looseness that is excessive .....	B	.....	(4) (5) Require replacement.
Nut on stud loose .....	A	.....	(6) Require repair or replacement of nut.
Seized .....	A	.....	Require replacement.
Stud bent .....	B	.....	(7) Require replacement.
Stud broken .....	A	.....	(7) Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	(7) Require replacement.
Wear exceeds manufacturer's specifications .....	B	.....	Require replacement.

- (1) - Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (2) - Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) - Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) - If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

- (5) - Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (6) - Check for bent stud or damaged taper hole.
- (7) - Check for damaged taper hole.

## TRAILING ARMS

### TRAILING ARM INSPECTION

Condition	Code	Procedure
Attaching hardware broken .....	A	... Require replacement of broken part, if available; otherwise, replace trailing arm.
Attaching hardware loose .....	A	... Require repair or replacement of loose part, if available;

otherwise, replace trailing arm.

Attaching hardware missing .....	C	..	Require replacement of missing part, if available; otherwise, replace trailing arm.
Attaching hardware threads damaged .....	A	...	Require repair or replacement of part with damaged threads, if available; otherwise, replace trailing arm.
Attaching hardware threads stripped (threads missing) .....	A	.....	Require replacement of part with stripped threads, if available; otherwise, replace trailing arm.
Bent .....	B	.....	Require replacement.
Bushing hole oversized ..	B	.....	Require replacement.
Corroded, affecting structural integrity ...	A	.....	Require replacement.
Holes distorted .....	A	.....	Require replacement.
Threads damaged .....	A	..	Require repair or replacement.
Threads stripped (threads missing) .....	A	.....	Require replacement.

## WHEEL BEARINGS, RACES AND SEALS

NOTE: When replacing or repacking wheel bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

### WHEEL BEARING, RACE AND SEAL INSPECTION

Condition	Code	Procedure
Rear axle seal on rear-wheel drive leaking ....	A	..... Require replacement of seal and inspection of axle, bearing, housing, and vent tube.
Seal bent .....	1	..... Suggest replacement.
Seal leaking .....	A	. Require replacement of seal and inspection of bearings.
Seal missing .....	C	..... Require replacement.
Seal torn .....	A	..... Require replacement.
Wheel bearing assembly feels rough when rotated .....	A	.. Require replacement of bearing assembly.
Wheel bearing balls are pitted .....	A	.. Require replacement of bearing assembly.
Wheel bearing balls are worn .....	A	.. Require replacement of bearing assembly.
Wheel bearing end-play exceeds vehicle manufacturer's specifications .....	B	.. Require adjustment of bearing,

if possible. If proper adjustment cannot be obtained, require repair or replacement of worn component.

Wheel bearing race is loose in the hub bore .....	A	.....	Require replacement of hub assembly and wheel bearings.
Wheel bearing races are pitted .....	A	..	Require replacement of bearing assembly.
Wheel bearing races are worn .....	A	..	Require replacement of bearing assembly.
Wheel bearing rollers are pitted .....	A	..	Require replacement of bearing assembly.
Wheel bearing rollers are worn .....	A	..	Require replacement of bearing assembly.

## WHEEL ALIGNMENT

### WHEEL ALIGNMENT

Wheel alignment is defined as the measurement, analysis, and adjustment of steering and suspension angles to conform to OEM specifications. These angles usually include, but are not limited to: caster, camber, toe, and thrust angle. Where these angles are not adjustable and not in specification, component replacement or correction kits may be required. Errors in set-back and steering axis inclination (SAI) are often attributable to failed or damaged components and must be corrected prior to performing an alignment.

Failure to replace or correct suggested parts or service may prevent a proper alignment.

Before performing an alignment check, inspect and verify the following:

- \* Tire pressure and size
- \* Vehicle loading
- \* Ride height
- \* Steering and suspension parts

If the inspection reveals that all the above are within published specifications, a wheel alignment check and an alignment, if needed, may be performed.

**CAUTION:** Under no circumstances should a technician bend or heat any steering or suspension component, unless specified by the vehicle manufacturer, for example, Ford forged twin "I" beam axles. All measurements and specifications must be noted on the inspection report.

### WHEEL ALIGNMENT INSPECTION

Condition	Code	Procedure
Dog tracking, shown to be caused by faulty alignment .....	2	Suggest repair.
Lead, shown to		



be caused by faulty alignment	.....	A	.....	Require alignment.
Part has been changed, affecting alignment	....	A	.....	Require alignment check.
Pull, shown to be caused by faulty alignment	....	A	.....	Require alignment.
Steering wheel off-center	.....	2	.....	Suggest alignment.
Tire wear, shown to be caused by faulty alignment	.....	A	.....	Require alignment.
Wander, shown to be caused by faulty alignment	.....	A	.....	Require alignment.

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## WHEELS AND TIRES

### TIRES

These guidelines do not apply to split rims. Some vehicle manufacturers restrict replacement of tires to specific brands, types, or sizes.

**WARNING:** High pressure temporary compact spare tires should not be used with any other rims or wheels, nor should standard tires, snow tires, wheel covers, or trim rings be used with high pressure compact spare rims or wheels. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death.

**WARNING:** Only specially trained persons should dismount or mount tires. Explosions of tire and wheel assembly can result from improper mounting, possibly causing serious injury or death.

**WARNING:** Consult the vehicle owner's manual or vehicle placard for correct size, speed rating, designation, and cold inflation pressure of the original tires. DO NOT exceed the maximum load or inflation capacity of the tire specified by the Tire and Rim Association

**WARNING:** When replacing tires, it is suggested that the replacement tires match or exceed the OEM speed rating designation. If tires of different speed rating designations are mixed on the same vehicle, the tires may vary in handling characteristics. DO NOT mix different speed rating designations on the same axle.

**WARNING:** DO NOT mix radials with non-radial tires on the same axle, as this may affect vehicle handling and stability. If radial tires and bias or bias-belted ply tires are mixed on the same vehicle, the radials must be on the rear. High-pressure temporary compact spare tires are exempt from this rule.

**WARNING:** DO NOT mix size or type (all season, performance, mud and snow) of tires on the same axle.

### TIRE INSPECTION

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Condition	Code	Procedure
Air pressure incorrect ..	B	..... Require repair
Bead broken .....	A	..... Require replacement.
Bead leaking, caused by tire .....	A	.. Require repair or replacement.
Bead wire/cord exposed ..	A	..... Require replacement.
Cord or belt material exposed .....	A	..... Require replacement.
Cord ply separations ....	A	..... Require replacement.
Directional/asymmetrical tires mounted incorrectly .....	B	..... Require remounting and/or repositioning.
Irregular tread wear, affecting performance ..	2	..... (1) Suggest replacement.
Load ratings less than OEM specifications .....	B	..... Require replacement.
Mixed tread types (all season, performance, mud and snow) on same axle .	A	..... Require replacement.
Number of punctures exceeds manufacturer's limit .....	B	..... Require replacement.
Out of balance .....	B	. Require rebalance of tire/wheel assembly.
Ply separation .....	A	..... Require replacement.
Pull or lead, caused by tire .....	A	.. Require repair or replacement.
Radial and bias or bias-belted ply tires on same axle .....	B	.. Require repair or replacement.
Radials are on the front and not on the rear ....	B	..... (2) Require repair or replacement.
Run flat damage .....	A	..... Require replacement.
Shoulder cut .....	A	..... Require replacement.
Shoulder puncture .....	A	..... Require replacement.
Shoulder with plug .....	A	..... Require replacement.
Sidewall bulge .....	A	..... Require replacement.
Sidewall cut .....	A	..... Require replacement.
Sidewall indentation ....	..	..... No service required or suggested.
Sidewall puncture .....	A	..... Require replacement.
Sidewall with plug .....	A	..... Require replacement.
Speed rating designations different on same axle .....	2	.. Suggest repair or replacement.
Tire and wheel assembly has excessive run-out ..	B	..... (3) Require repair or replacement of appropriate part.
Tires with more than 1/4" diameter difference on a four-wheel drive vehicle .....	B	..... Require replacement.
Tread area puncture larger in diameter than manufacturer's specifications .....	B	..... Require replacement.
Tread missing pieces		

- (1) - Determine and correct cause of irregular tire wear.
- (2) - If radials and bias or bias-belted ply tires are on the same vehicle, the radials must be on the rear axle, except for high-pressure temporary spares.
- (3) - Excessive is defined as enough to contribute to performance problems. Match mounting may correct run-out. If not, require replacement of appropriate part. Refer to manufacturer's specifications.
- (4) - Most manufacturers do not recommend tubes in tubeless tires. Inspect tire and wheel assembly to determine the reason for a tube in tubeless tire. Recommendation for repair or replacement should be based upon condition of tires and/or wheel listed in these guidelines.

## VALVE STEM INSPECTION

Condition	Code	Procedure
Bent .....	1	Suggest replacement.
Broken .....	A	Require replacement.
Cut, but not leaking ....	1	Suggest replacement.
Deteriorated (cracking, dry rot) ....	1	Suggest replacement.
Leaking .....	A	Require repair or replacement.
Missing .....	C	Require replacement.
Threads damaged .....	A	Require repair or replacement.
Threads stripped .....	A	Require replacement.
Valve cap missing .....	C	Require replacement of cap.
Weather-checking .....	1	Suggest replacement.
Won't take air .....	A	Require repair or replacement.

For conditions noted below, also check conditions of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow recommended torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

Condition	Code	Procedure
Bent .....	A .....	Require replacement.
Broken .....	A ..... (1)	Require replacement.

Loose .....	B	...	Require repair or replacement of affected component.
Lug nut installed backward .....	B	..	Require repair or replacement.
Lug nut mating type incorrect .....	B	.....	Require replacement of nut.
Lug nut mating surface dished .....	A	.....	Require replacement of nut.
Lug nut rounded .....	A	.	(2) Require replacement of nut.
Lug nut seized .....	A	.	(2) Require replacement of nut.
Stud incorrect .....	B	....	Require replacement of stud.
Threads damaged .....	A	...	Require repair or replacement of component with damaged threads.
Threads stripped .....	A	.....	Require replacement of component with stripped threads.

- (1) - Some manufacturers require replacement of all studs on that wheel if two or more studs or nuts on the same wheel are broken or missing.
- (2) - Only required if removing wheel.
- 

## WHEELS (RIMS)

**WARNING:** Mounting a regular tire on a high-pressure compact spare wheel is not permitted. Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death. If the wheel identification stamp is not legible, or cannot be found, do not use the wheel until the size and type have been properly identified. Wheels of different diameter, offset, or width cannot be mixed on the same axle. Bead seat tapers cannot be interchanged.

### WHEEL (RIM) INSPECTION

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Condition	Code	Procedure
Bead leaking, caused by wheel .....	A	..... (1) Require repair or replacement.
Bent hub mounting surface .....	A	..... Require replacement.
Bent rim, causing vibration .....	2	..... (1) Suggest replacement.
Broken .....	A	..... Require replacement.
Cast wheel porous, causing a leak .....	A	.. Require repair or replacement.
Clip-on balance weight is incorrect type for rim flange .....	2	..... Suggest replacement.
Corrosion, affecting structural integrity ...	A	..... Require replacement.
Corrosion build-up on wheel mounting surface .....	A	..... Require repair.
Cracked .....	A	..... Require replacement.
Directional/asymmetrical wheels mounted incorrectly .....	B	..... Require remounting and/or repositioning.

Load capacity less than OEM specifications .....	B	.....	Require replacement.
Offset mismatched on same axle .....	B	.....	Require replacement.
Rivets leaking .....	A	.....	Require replacement.
Run-out beyond OEM specs .....	B	.....	Require replacement.
Stud holes elongated ....	A	..... (2)	Require replacement.
Welded or brazed repair .....	2	.....	Suggest replacement.
Welds leaking .....	A	.....	Require replacement.
Wheel centering (pilot) hole incorrect .....	B	.....	Require replacement.

(1) - CAUTION: DO NOT attempt to correct a bent rim.

(2) - Inspect wheel attaching hardware for damage.

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# SUSPENSION - FRONT

## 1993 Jeep Cherokee

1993 SUSPENSION  
Chrysler Corp. Front

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION

On all models except Wrangler, front suspensions consist of axle, 2 coil springs, track bar, stabilizer bar and upper and lower control arms. Track bar is used to minimize front axle side-to-side movement. Stabilizer bar and shock absorbers control suspension spring movement.

Wrangler models use leaf spring front suspension with shock absorbers, stabilizer bar and a track bar.

### ADJUSTMENTS & INSPECTION

#### WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

NOTE: See SPECIFICATIONS & PROCEDURES article in WHEEL ALIGNMENT.

#### WHEEL BEARING

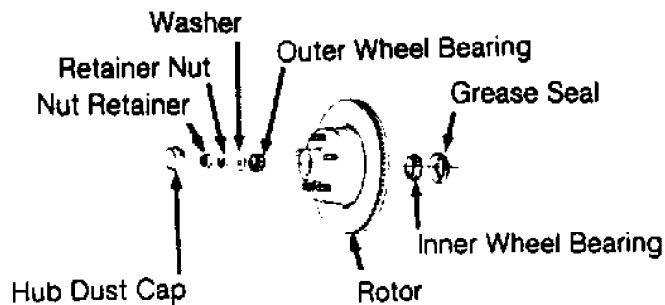
NOTE: Wheel bearings on all 4WD models are nonadjustable. If wheel bearings require service, see WHEEL BEARINGS under REMOVAL & INSTALLATION.

2WD

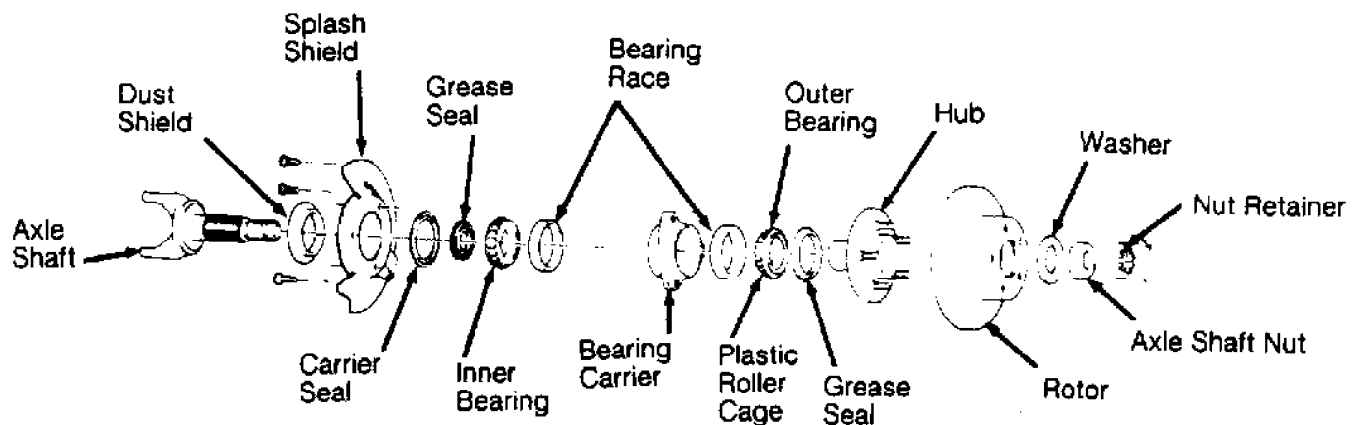
1) Raise and support vehicle. Turn wheel by hand while placing fingers of free hand on rotor shield. If any roughness is detected proceed to WHEEL BEARINGS under REMOVAL & INSTALLATION. Remove wheel and tire assembly. See Fig. 1.

2) Remove hub dust cap, cotter pin and nut retainer. Ensure bearings are thoroughly packed with lithium grease. Rotate hub and rotor assembly by hand, tighten retainer nut to 21 ft. lbs. (29 N.m) to seat bearings.

3) Loosen retainer nut 1/2 turn while rotating hub. Then retighten nut to 19 INCH lbs. (2 N.m). Install nut retainer and new cotter pin. Clean hub dust cap and coat inside with clean grease. Reverse removal procedure for remaining components.



2WD MODELS



4WD MODELS

Fig. 1: 2WD Hub/Rotor Assy. & 4WD Hub/Bearing Carrier Assy.  
Courtesy of Chrysler Corp.

## REMOVAL & INSTALLATION

### WHEEL BEARINGS

#### Removal (2WD)

1) Raise and support vehicle. Remove wheel assembly. Remove brake caliper and suspend caliper with wire. DO NOT allow caliper to hang on brake hose.

2) Remove hub dust cap, cotter pin, nut retainer, nut, washer and outer wheel bearing. Remove rotor and hub assembly. Pry grease seal from hub. Remove inner wheel bearing.

**WARNING:** DO NOT allow bearings to spin freely when drying with compressed air. Damage to bearings or serious injury could occur.

#### Inspection

Clean bearings and hub in solvent and dry with compressed air. Inspect bearings and races for damage or excessive wear.

#### Installation (2WD)

To install, reverse removal procedure. Pack bearings with wheel bearing grease. Adjust wheel bearings. See WHEEL BEARING under

## ADJUSTMENTS & INSPECTION.

NOTE: On 4WD models, front wheel bearings cannot be serviced separately. If defective, hub and bearing must be replaced as an assembly. See HUB & BEARING under REMOVAL & INSTALLATION in FRONT AXLES article in DRIVE AXLES.

## SHOCK ABSORBER

### Removal & Installation

With vehicle at normal ride height, remove nut, washer and rubber grommet from top of shock absorber. Raise and support vehicle. Remove lower shock mounting bolts from axle housing bracket. Remove shock absorber. Inspect units for damage or leakage. To install, reverse removal procedure.

## STEERING KNUCKLE

### Removal

1) Raise and support vehicle. Remove wheel, disc brake caliper, rotor, cotter pin, nut retainer, and axle hub nut. Remove hub-to-steering knuckle attaching bolts. Remove hub and rotor shield from steering knuckle. Remove axle shaft from axle tube. See FRONT AXLES article in DRIVE AXLES.

NOTE: DO NOT disconnect caliper unless service is needed. Support caliper with wire to prevent hose damage.

2) On models with front axle shift motor, remove outer axle shaft from right axle tube. Leave shift collar on intermediate shaft. On all models, remove caliper anchor plate from steering knuckle. Remove steering knuckle and ball joint cotter pins. Remove ball joint nuts. Strike steering knuckle at ball joint stud boss with a brass hammer to loosen knuckle from ball joint studs. Remove steering knuckle. See Fig. 2.

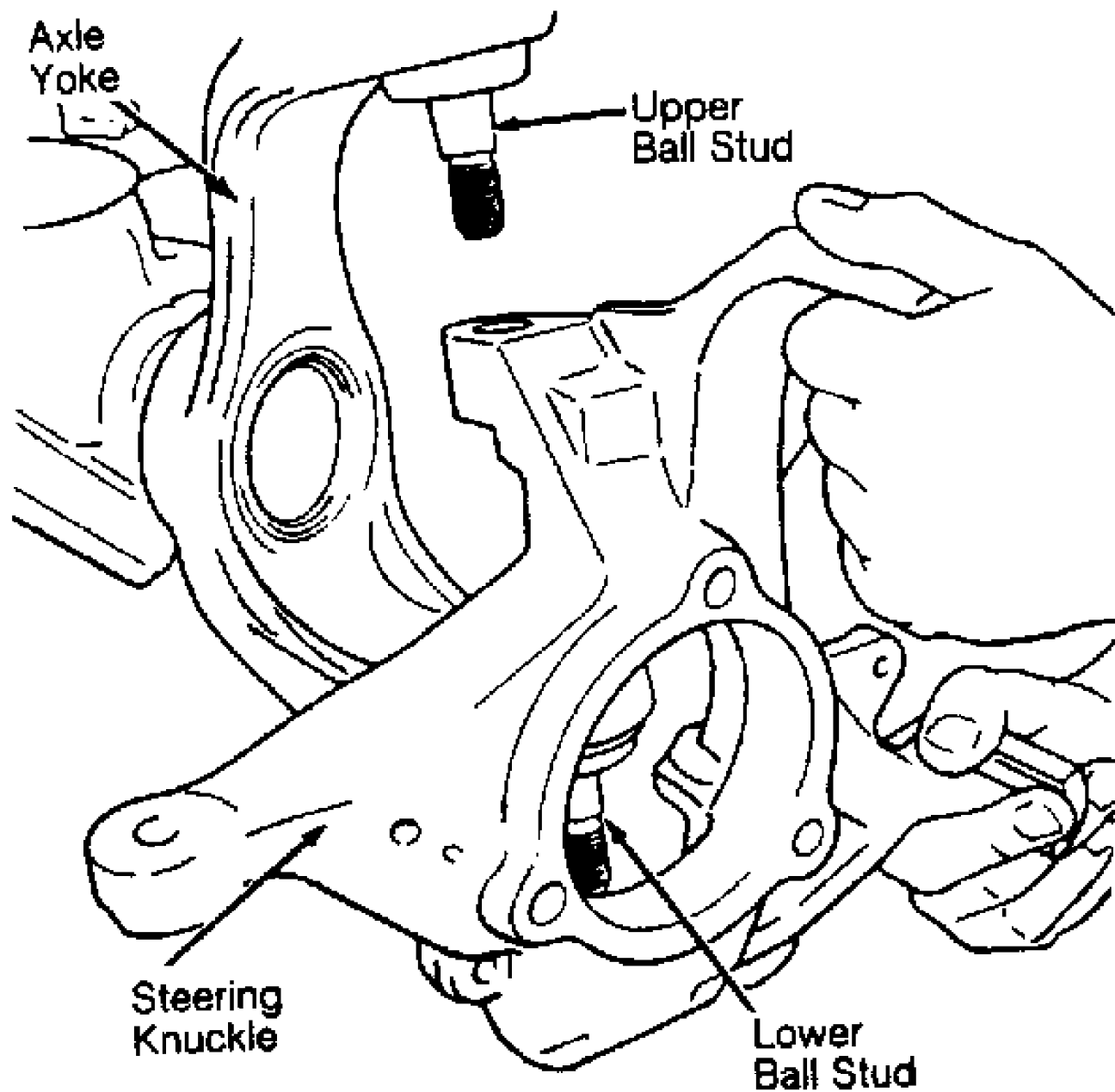
### Installation

1) Position steering knuckle over ball joint studs and install nuts. Tighten nuts to specification. Install NEW cotter pins. Install caliper anchor plate and tighten bolts to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article. Install axle shafts into axle tubes.

2) On vehicles with front axle shift motor, ensure shift collar is correctly positioned on intermediate axle shaft, install axle into shift collar inside axle tube. Ensure axle shaft is completely engaged with shift collar.

3) On all models, apply bearing grease to spindle hub bore in steering knuckle and install rotor shield and hub. Tighten spindle hub bolts. Install hub washer and nut. Tighten hub nut to specification. Install hub nut retainer and install NEW cotter pin. Install rotor, caliper and wheel. Lower vehicle.





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Fig. 2: Removing & Installing Steering Knuckle Assembly  
Courtesy of Chrysler Corp.

#### ANTI-LOCK BRAKE WHEEL SPEED SENSOR

Removal & Installation (Cherokee 4WD, Grand Cherokee & Grand Wagoneer)

1) Raise and support front of vehicle. Note sensor wire routing for installation reference. Clean area around sensor to prevent damage during removal. Remove wheel speed sensor from steering knuckle. Unseat sensor wire retaining grommet.

2) Inside engine compartment, unplug sensor connector from anti-lock harness connector. Remove sensor. To install, reverse removal procedure. See Fig. 3.

NOTE: Air gap between ABS wheel speed sensor and tone wheel is not adjustable.

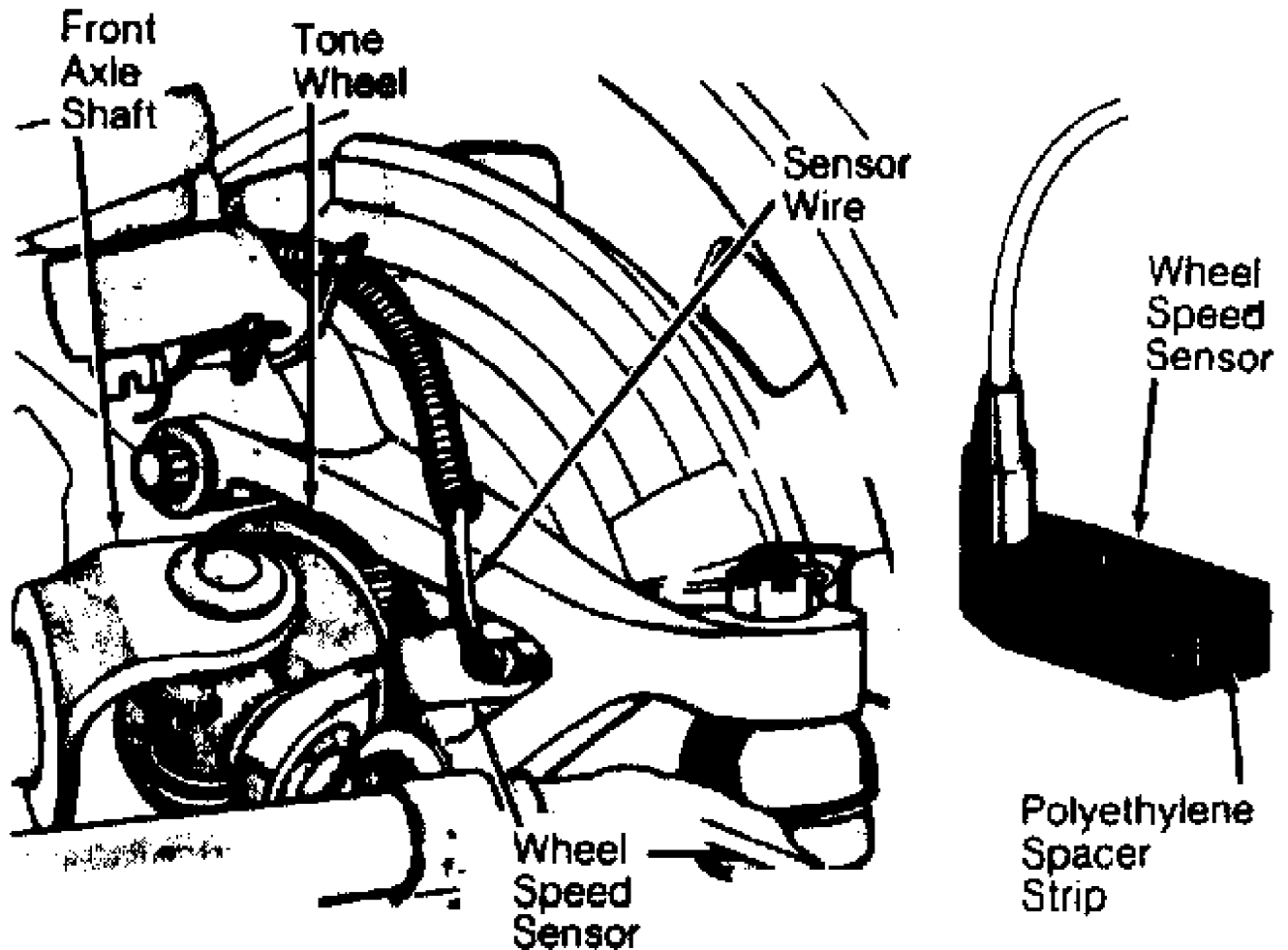


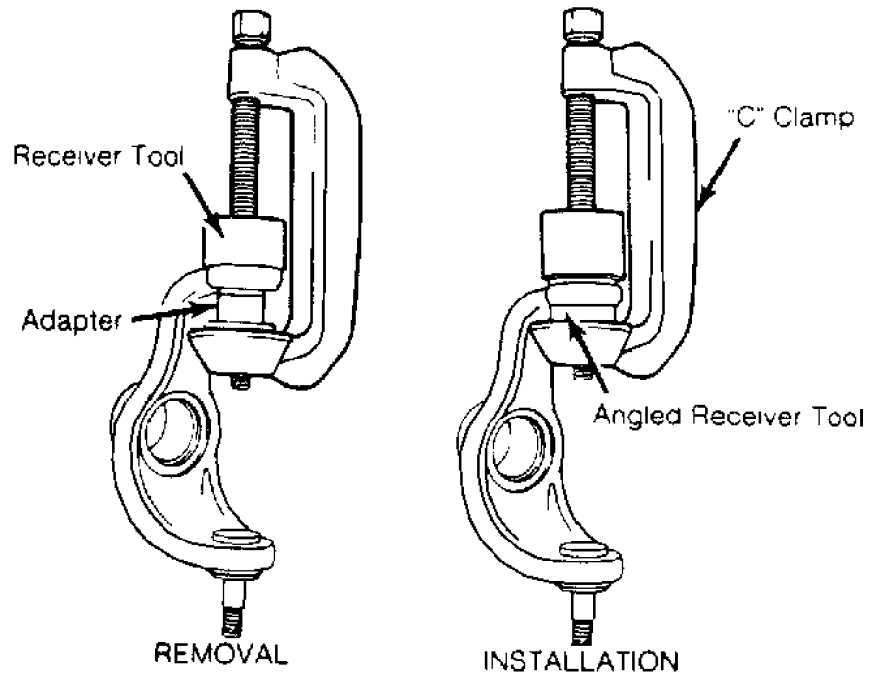
Fig. 3: Locating Anti-Lock Brake Wheel Speed Sensor  
Courtesy of Chrysler Corp.

## UPPER & LOWER BALL JOINTS

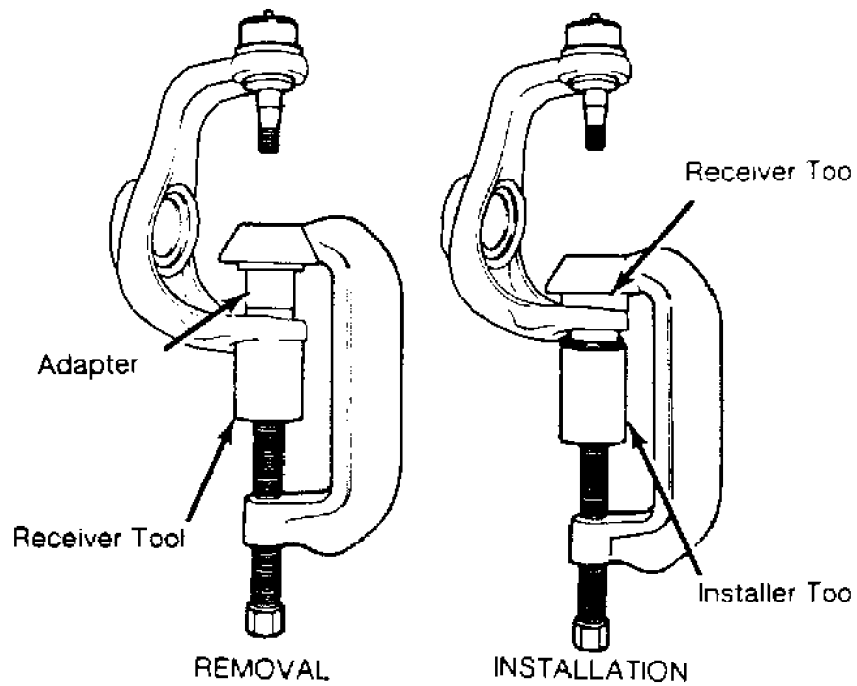
### Removal

1) Remove steering knuckle assembly. See STEERING KNUCKLE. To remove upper ball joint, install Receiver (J-34503-1) over top of upper ball joint. Place Adapter (J-34503-3) in "C" clamp. Install "C" clamp, adapter and receiver. Tighten "C" clamp screw to remove ball joint. See Fig. 4.

### UPPER BALL JOINT



### LOWER BALL JOINT



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Fig. 4: Removing & Installing Ball Joint  
Courtesy of Chrysler Corp.

2) To remove lower ball joint, position Receiver (J-34503-1) onto "C" clamp and Adapter (J-34503-3) at base of clamp. See Fig. 4.

Install "C" clamp, adapter and receiver. Tighten "C" clamp to remove ball joint. See Fig. 4.

#### Installation

1) Place upper ball joint in position. Position Ball Joint Installer (J-34503-5) over new upper ball joint. Install Receiver (J-34503-12) and "C" clamp. Tighten "C" clamp and fully seat ball joint. See Fig. 4.

2) To install lower ball joint, position Ball Joint Installer (J-34503-4), "C" clamp and Receiver (J-34503-12). See Fig. 4. Tighten "C" clamp to install ball joint. Ensure ball joint is fully seated. Install steering knuckle. See TORQUE SPECIFICATIONS TABLE at the end of this article.

## COIL SPRING

#### Removal & Installation

1) Raise and support vehicle on frame rails. Remove wheel assembly. On 4WD models, Place reference mark on drive shaft and front axle flanges. Disconnect drive shaft at front axle.

2) Place jack stand under axle housing. Disconnect lower control arms at axle housing. Disconnect stabilizer bar links and lower shock absorber mounting bolts at axle housing. Disconnect track bar at frame rail bracket. Disconnect tie rod from pitman arm.

3) Lower axle housing to relieve spring pressure. Remove spring retainer mounting bolt. Remove spring retainer and coil spring. Note component location for reassembly reference. To install, reverse removal procedure.

## LEAF SPRING

#### Removal & Installation

1) Raise and support vehicle. Raise axle assembly with jack to relieve spring tension. Remove wheels and loosen stabilizer bar link nut.

2) Remove spring "U" bolts and plate. Remove spring-to-front shackle bolt and spring-to-rear frame hanger bolt. Remove spring. To install, reverse removal procedure. Ensure spring center bolt is seated in axle housing. Tighten spring-to-front shackle bolt and spring-to-rear frame hanger bolt with vehicle at normal operating height. See TORQUE SPECIFICATIONS TABLE at the end of this article.

## UPPER CONTROL ARM & AXLE HOUSING PIVOT BUSHING

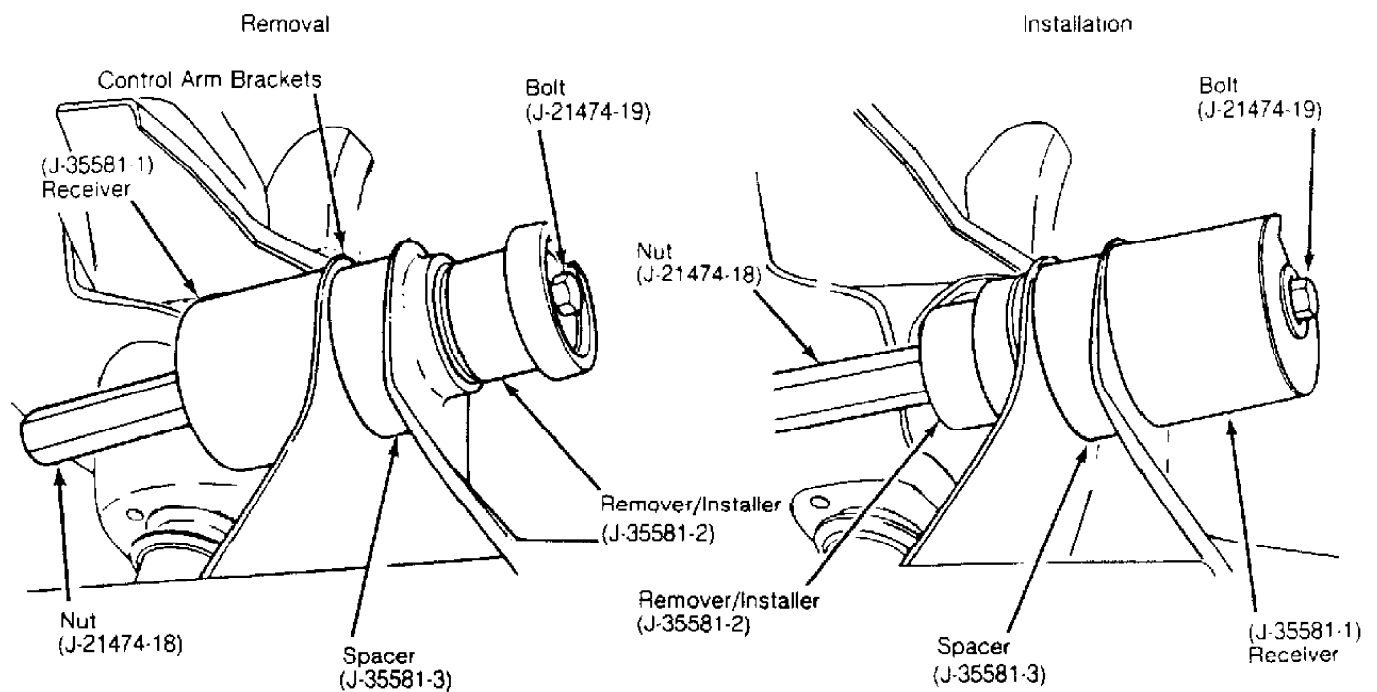
#### Removal & Installation

1) Raise vehicle and remove upper control arm mounting bolt from axle housing. Disconnect control arm mounting bolt at frame rail. Remove upper control arm.

2) Inspect control arm for damage or distortion and replace as needed. Check pivot bushings for excessive distortion, deterioration or wear.

3) If pivot bushing requires replacement, on 2WD models, install Spacer (J-33581-3) between ears of control arm bracket on axle housing. See Fig. 5.

NOTE: Spacer (J-33581-3) is not used on 4WD models, as solid control arm brackets are used. DO NOT attempt to remove upper control arm pivot bushing on 2WD models without spacer. Axle bracket will be distorted if spacer is not used.



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Fig. 5: Removing & Installing Upper Control Arm Bushing  
Courtesy of Chrysler Corp.

4) Install Bushing Remover/Installer Set (J-35581, which includes Spacer J-35581-3, Remover/Installer J-35581-2, Receiver J-35581-1, Bolt J-21474-19 and Nut J-21474-18) onto pivot bushing. See Fig. 5.

5) Rotate nut to press bushing from axle housing and into receiver. See Fig. 5. Once bushing is removed, remove bushing remover/installer components.

**CAUTION:** On 2WD models, spacer must remain installed for bushing installation.

6) Position bushing on Remover/Installer (J-35581-2) and Nut (J-21474-18). Position bushing and installer components in control arm bracket. Assemble remaining installer components. See Fig. 5.

7) Rotate nut to press bushing into housing until fully seated in bore. See Fig. 5. Remove bushing installer components. To install upper control arm, reverse removal procedure.

## LOWER CONTROL ARM

### Removal & Installation

Raise and support vehicle. Support axle. Disconnect lower control arm mounting bolts at axle housing and frame brackets. Remove lower control arm. To install, reverse removal procedure.

## TRACK BAR

### Removal & Installation

1) Raise and support vehicle. Remove cotter pin (if used) and nut at frame rail bracket. Remove track bar-to-axle housing bracket.

2) On all models except Wrangler, track bar is fastened to frame bracket with a tapered rod end, similar to a tie rod. Use of a puller may be necessary to free track bar from bracket. Remove track

bar. To install, reverse removal procedure.

## FRONT STABILIZER BAR

### Removal & Installation

1) Raise and support vehicle. Disconnect stabilizer bar from stabilizer bar links. Remove stabilizer bar bracket-to-frame bolts. Remove brackets. Remove stabilizer bar and bushings.

2) To install, lubricate stabilizer bar bushings and grommets with rubber lubricant. Install stabilizer bar link brackets on axle (if removed). Tighten to specification. Install stabilizer bar and brackets on the frame. DO NOT tighten bolts at this time.

3) Install stabilizer bar-to-link bolts. Tighten stabilizer bracket-to-frame bolts to specification and then tighten stabilizer bar link bolts. See TORQUE SPECIFICATIONS TABLE at the end of this article.

## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Except Wrangler	
Axle Shaft Nut .....	175 (237)
Ball Joint Nut .....	75 (102)
Bearing Assembly-To-Steering Knuckle Bolt .....	75 (102)
Brake Caliper	
Anchor Bolt .....	77 (104)
Mounting Pin .....	30 (41)
Control Arm Bolt	
Upper	
At Axle .....	55 (75)
At Frame .....	66 (89)
Lower .....	133 (180)
Shock Absorber Nut (Lower) .....	14 (19)
Stabilizer Bar	
Frame Bolt .....	55 (75)
Link Bolt .....	27 (37)
Stabilizer Bar Link-To-Bracket Bolt .....	70 (95)
Tie Rod-To-Steering Knuckle Nut .....	35 (47)
Track Bar	
Frame Rail Bracket Nut .....	63 (85)
Axle Mount Bolt .....	74 (100)
Wheel Bearing Outer Lock Nut .....	50 (68)
Wheel Lug Nut .....	88-110 (119-149)
Wheel Speed Sensor Bolt .....	11 (15)
Wrangler	
Axle Shaft Nut .....	175 (237)
Ball Joint Nut .....	75 (102)
Bearing Assembly-To-Steering Knuckle Bolt .....	75 (102)
Brake Caliper	
Anchor Bolt .....	77 (104)
Mounting Pin .....	30 (41)
Shock Absorber	
Lower Bolt .....	45 (61)
Upper Stud Nut .....	10 (14)
Spring-To-Frame Bracket Bolt .....	105 (142)
Spring-To-Front Shackle Bolt .....	95 (129)
Spring "U" Bolt Nut .....	90 (122)
Stabilizer Bar	
Link Bolt .....	45 (61)

Mounting Bracket Bolt .....	55	(75)
Stabilizer Bar Link-To-Spring Bracket Nut .....	45	(61)
Tie Rod-To-Steering Knuckle Nut .....	35	(47)
Track Bar Bolt .....	74	(100)
Wheel Bearing Outer Lock Nut .....	50	(68)
Wheel Lug Nut .....	88-110	(119-149)

INCH Lbs. (N.m)

Axle Shift Motor Bolt .....	101	(11)
Shock Absorber Nut (Upper) .....	96	(10)

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# **\* SYMPTOM CHECK LIST \***

1993 Jeep Cherokee

## SYMPTOM CHECK LIST WORKSHEETS

### **\* PLEASE READ THIS FIRST \***

NOTE: This article is intended for general information purposes only. It does not apply specifically to one make or model.

### **PURPOSE**

Why Use the Symptom Check List Worksheets?

One of the most difficult and critical lines of communication is between the service customer and the technician. The clearer the technician understands the customer's concerns, the more likely the problem will be "fixed right the first time".

The Symptom Check List Worksheets in this article are designed to improve this communication. When used consistently, they can be helpful in reducing shop comebacks, increasing technician productivity, and producing satisfied customers. They also provide other benefits:

- \* Reduce "No Trouble Found" problems
- \* Increase customer involvement
- \* Customer perceive that "they really care and listen"
- \* Save time during peak write-up periods
- \* Reduce recontacting customers for additional information
- \* Improve night drop information
- \* Insure all the right questions are asked at write-up

Making the Worksheets a Part of Your Normal Routine

The following information contains ideas that may be helpful in forming habits that promote daily use of the Symptom Check Lists:

- \* HAVE THE SERVICE ADVISER FILL OUT THE FORM(S) WITH THE CUSTOMER WHENEVER POSSIBLE.
- \* Place them in your night drop for the customer to fill out, along with an instruction sheet to help them understand what to do.
- \* Hand out the worksheets to customers while they wait in line during the peak morning rush and ask them to fill it out. It will save time for all concerned and improve the quality of information received from the customer.
- \* Make sure it is attached to the hard copy when it goes to the technician.
- \* Place a copy with the final repair papers and review it with the customer at delivery.
- \* Put a new worksheet in the glovebox of all departing customers.
- \* Require that you personally see a copy of all worksheets filled out for shop comebacks.
- \* Hold a shop meeting to get employee buy-in and their ideas on how to make it effective in your shop.

There are many other ways to utilize the concept, but as with every other idea, successful implementation depends on employee involvement and buy-in.

## **SYMPTOM CHECK LIST WORKSHEETS**



## CONDENSED VERSION - ALL ON ONE PAGE

NOTE: Have the service adviser fill out this form with the customer whenever possible.

<b>DRIVEABILITY WORKSHEET</b> ( To Be Filled Out By Vehicle Owner )	
<b>Name:</b> _____ <b>Date:</b> _____ <b>Make:</b> _____ <b>Model:</b> _____ <b>Year:</b> _____ <b>Engine:</b> _____ <b>Mileage:</b> _____	
FAULT CHARACTERISTICS - SYMPTOMS - DESCRIPTION OF PROBLEM ( Please Check All That Apply In All Categories )	
<b>Starting Problems</b>	<input type="checkbox"/> Will Not Crank <input type="checkbox"/> Cranks, But Won't Start <input type="checkbox"/> Starts, But Takes A Long Time
<b>Engine Quits/Running Problems</b>	<b>Quits:</b> <input type="checkbox"/> Right After Starting <input type="checkbox"/> When Put Into Gear <input type="checkbox"/> Right After Vehicle Comes To A Stop <input type="checkbox"/> During Steady Speed Driving <input type="checkbox"/> While Idling <input type="checkbox"/> During Acceleration <input type="checkbox"/> When Parking
<b>Poor Idling Conditions</b>	<b>Idle Speed:</b> <input type="checkbox"/> Is Too Slow At All Times <input type="checkbox"/> Is Too Slow With A/C On <input type="checkbox"/> Is Too Fast <input type="checkbox"/> Is Rough Or Uneven <input type="checkbox"/> Fluctuates Up and Down
<b>Poor Running Conditions</b>	<input type="checkbox"/> Runs Rough <input type="checkbox"/> Lacks Power <input type="checkbox"/> Hesitates Or Stumbles On Acceleration <input type="checkbox"/> Bucks and Jerks <input type="checkbox"/> Engine Knocks, Pings, Rattles <input type="checkbox"/> Backfires <input type="checkbox"/> Poor Fuel Economy <input type="checkbox"/> Misfires or Cuts Out <input type="checkbox"/> Surges and/or Chuggles <input type="checkbox"/> Dieseling or Run-On <input type="checkbox"/> Engine Light Always On <input type="checkbox"/> Engine Light On Sometimes <input type="checkbox"/> Fuel, Gas, or Sulfur Smell
<b>Auto. Transmission Problems</b>	<input type="checkbox"/> Improper Shifting ( early/late ) <input type="checkbox"/> Changes Gear Randomly On Its Own <input type="checkbox"/> Vehicle Does Not Move When In Gear
<b>Poor Handling</b>	<input type="checkbox"/> Pulls To One Side <input type="checkbox"/> Hard Steering <input type="checkbox"/> Vehicle Shakes and/or Vibrates While Moving
<b>Noise Problems</b>	<b>Explain:</b> _____
<b>Odor Problems</b>	<b>Explain:</b> _____
<b>Problem Frequency</b>	<input type="checkbox"/> Always <input type="checkbox"/> Often <input type="checkbox"/> Occasionally
<b>Usually Occurs</b>	<input type="checkbox"/> Morning <input type="checkbox"/> Afternoon <input type="checkbox"/> Anytime
<b>Engine Temp.</b>	<input type="checkbox"/> Cold <input type="checkbox"/> Warm <input type="checkbox"/> Hot
<b>Vehicle Speed</b>	<input type="checkbox"/> Low <input type="checkbox"/> Cruising <input type="checkbox"/> High
<b>Driving Conditions During Occurrence</b>	<input type="checkbox"/> Short - Less Than 2 Miles <input type="checkbox"/> 2-10 Miles <input type="checkbox"/> Long - More Than 10 Miles <input type="checkbox"/> Stop & Go <input type="checkbox"/> While Turning <input type="checkbox"/> While Braking <input type="checkbox"/> At Gear Engagement <input type="checkbox"/> With A/C Operating <input type="checkbox"/> With Headlights On <input type="checkbox"/> During Acceleration <input type="checkbox"/> During Deceleration <input type="checkbox"/> Mostly Downhill <input type="checkbox"/> Mostly Uphill <input type="checkbox"/> Mostly Level <input type="checkbox"/> Mostly Curvy <input type="checkbox"/> Rough Road
<b>Driving Habits</b>	<input type="checkbox"/> Drive Hard Before Engine Is Warmed <input type="checkbox"/> Allow Engine To Warm <input type="checkbox"/> Mostly City Driving <input type="checkbox"/> Highway <input type="checkbox"/> Park Vehicle Inside <input type="checkbox"/> Outside <b>Drive Per Day:</b> <input type="checkbox"/> Less Than 10 Miles <input type="checkbox"/> 10-50 <input type="checkbox"/> More Than 50 <b>Fuel Octane:</b> <input type="checkbox"/> 87 <input type="checkbox"/> 89 <input type="checkbox"/> 91 <input type="checkbox"/> More Than 91 <b>Brand:</b> _____ <input type="checkbox"/> Gasohol <input type="checkbox"/> Propane Conversion
<b>Outside Weather</b>	<input type="checkbox"/> Cold <input type="checkbox"/> Warm <input type="checkbox"/> Hot <input type="checkbox"/> Wet/Rainy <input type="checkbox"/> Fog <input type="checkbox"/> Snow/Hail <input type="checkbox"/> Dust/Dirt <input type="checkbox"/> Dry <input type="checkbox"/> Humid

Fig. 1: Entire Vehicle - Symptom Check List For Customer

## FULL VERSION - ALL ON FOUR PAGES

NOTE: Have the service adviser fill out these forms with the

customer whenever possible.

**Dear Valued Customer:**

Our goal is to fix your problem correctly and get you back on the road as soon as possible in the unlikely event you experience a problem with your vehicle. Help us identify the exact nature of the concern by taking a few moments to complete the appropriate section of this diagnostic worksheet. Thank you.

CUSTOMER NAME: \_\_\_\_\_

PHONE NO.: \_\_\_\_\_

REPAIR ORDER NO.: \_\_\_\_\_

## DIAGNOSTIC WORKSHEET

### DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION

**SYMPTOM (CHECK ALL THAT APPLY)**  
**ENGINE**

- ☐ "Service Engine Soon"/"Malfunction Indicator Light" on
- ☐ Hard start/no start (cranks OK)
- ☐ Won't crank
- ☐ Engine stalls
- ☐ Engine miss
- ☐ Miss while driving
- ☐ Hesitates, stumbles or sags
- ☐ Rough idle
- ☐ Idle is too high ☐ Idle is too low
- ☐ Poor power/performance
- ☐ Surge or chuggle, buck - jerk - skip
- ☐ Poor gas mileage ☐ Highway ☐ City
- ☐ Pings, detonates
- ☐ Suphur, rotten egg odor
- ☐ Backfires (popping noise) - underhood/tailpipe
- ☐ Exhaust smoke ☐ Increased oil consumption
- ☐ Runs on after key is turned off
- ☐ Speed fluctuates without moving accelerator
- ☐ Engine noise (explain): \_\_\_\_\_

(whine, rattle, groan, clunk, etc.)

- ☐ Other: \_\_\_\_\_

**TRANSMISSION**

- ☐ Does not shift properly ☐ Hard shift
- ☐ Will not shift ☐ Up ☐ Down
- ☐ Will not shift into overdrive
- ☐ Engine starts in other than "P" or "N"
- ☐ Noise (describe): \_\_\_\_\_

(whine, rattle, groan, clunk, buzz, etc.)

- ☐ Shifts into gear too early
- ☐ Overdrive doesn't work with speed control, but is otherwise OK
- ☐ Highway speed - shudder, surge, etc.
- ☐ Other: \_\_\_\_\_

EXPLAIN: \_\_\_\_\_

**OPERATING CONDITIONS (CHECK ALL THAT APPLY)**  
**HOW OFTEN DOES IT OCCUR? (Engine and/or Transmission)**

- ☐ Always ☐ Few seconds ☐ Few minutes
- ☐ Few hours ☐ Few days ☐ Few weeks
- ☐ Few months ☐ Variable ☐ Only during event
- ☐ Every \_\_\_\_\_ to \_\_\_\_\_ miles ☐ Unknown
- ☐ Other (explain): \_\_\_\_\_
- ☐ Just started ☐ Getting better ☐ Getting worse
- ☐ Since new

**WHEN DOES IT OCCUR? (Engine and/or Transmission)**  
**When Engine Temperature is:**

- ☐ Cold ☐ Warm ☐ Hot
- ☐ All the time ☐ Only during warmup

**Weather Conditions:**

- ☐ Very cold - below 0 degrees F ☐ Cold - 0 to 32 degrees F
- ☐ Cool - 32 to 60 degrees F ☐ Warm - 60 to 80 degrees F
- ☐ Hot - Above 80 degrees F ☐ Any environment
- ☐ Raining ☐ Dry ☐ Humid
- ☐ Snow/ice ☐ Wet roads ☐ Other (explain below)

**Driving Conditions:**

- ☐ Light throttle ☐ Medium throttle ☐ Hard throttle
- ☐ Starting ☐ At idle ☐ Decelerating
- ☐ Over bumps ☐ When shifting ☐ While turning
- ☐ Cruising steady at \_\_\_\_\_ MPH ☐ While braking
- ☐ Anytime ☐ Uphill ☐ Downhill
- ☐ Highway ☐ City/town ☐ Stop and go
- ☐ Between \_\_\_\_\_ MPH and \_\_\_\_\_ MPH
- ☐ Only with A/C or Defrost on

**What Type of Fuel?**

- ☐ Regular UL ☐ Mid range UL ☐ Premium Unleaded
- ☐ Gasohol ☐ Ethanol ☐ Methanol
- ☐ Diesel #1 ☐ Diesel #2 ☐ Various brands

**What Brand? \_\_\_\_\_**

**When Gear Selector is in:**

- ☐ Park/Neutral ☐ Reverse ☐ Overdrive
- ☐ Drive/3 ☐ Drive/2 ☐ Drive/1

**Between Gears:**

- ☐ Park to R or D ☐ Rev/Drive ☐ First/Second
- ☐ Second/Third ☐ Third/Overdrive

**BRAKES - STEERING - SUSPENSION****SYMPTOM**

- |   |  |                                       |
|---|--|---------------------------------------|
| <input type="checkbox"/> Vehicle pulls right - When _____           | <input type="checkbox"/> Suspension bottoms out    | <input type="checkbox"/> Sits uneven  |
| <input type="checkbox"/> Vehicle pulls left - When _____            | <input type="checkbox"/> Leans or sways in corners | <input type="checkbox"/> "Dog" tracks |
| <input type="checkbox"/> Steering wheel vibrates at _____ MPH       | <input type="checkbox"/> Brake light on            | <input type="checkbox"/> ABS light on |
| <input type="checkbox"/> Excessive play in steering                 | <input type="checkbox"/> Traction control light on | <input type="checkbox"/> Soft ride    |
| <input type="checkbox"/> Erratic steering when braking              | <input type="checkbox"/> Uneven tire wear          |                                       |
| <input type="checkbox"/> Poor steering wheel return after cornering |  |                                       |

**Hard to steer**

- ☐ Effort                      ☐ Wanders  
☐ Steering wheel off center

**Shimmy/vibration (check box below for location)**

- |                                |                                |                                      |
|--------------------------------|--------------------------------|--------------------------------------|
| <input type="checkbox"/> Front | <input type="checkbox"/> Rear  | <input type="checkbox"/> Don't know  |
| <input type="checkbox"/> Seat  | <input type="checkbox"/> Floor | <input type="checkbox"/> Other _____ |

**Brake pedal**

- ☐ Noise                      ☐ Pulses                      ☐ Squeaks                      ☐ Hard                      ☐ Mushy                      ☐ Excessive travel

**WHEN DOES IT OCCUR?**

- |  |  |                                       |                                       |                                       |
|--|--|---------------------------------------|---------------------------------------|---------------------------------------|
| <input type="checkbox"/> Cold days         | <input type="checkbox"/> Hot days      | <input type="checkbox"/> Wet/rain     | <input type="checkbox"/> All the time | <input type="checkbox"/> Intermittent |
| <input type="checkbox"/> Parking maneuvers | <input type="checkbox"/> At road speed | <input type="checkbox"/> Accelerating | <input type="checkbox"/> Decelerating |                                       |

**EXPLAIN:** \_\_\_\_\_**SQUEAK - RATTLE - NOISE CONDITIONS****AREA OF NOISE**

- |  |                                  |                                      |                                 |                                     |
|--|----------------------------------|--------------------------------------|---------------------------------|-------------------------------------|
| <input type="checkbox"/> Engine Compartment    | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Front Suspension      | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Rear Suspension       | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Passenger Compartment | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Instrument Panel      | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Doors                 | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Rear seat area        | <input type="checkbox"/> Console | <input type="checkbox"/> Other _____ |                                 |                                     |

**NOISE SOUNDS LIKE**

- |                                  |                                     |                                      |                                      |                                  |                                |
|----------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|--------------------------------|
| <input type="checkbox"/> Knocks  | <input type="checkbox"/> Hard metal | <input type="checkbox"/> Light metal | <input type="checkbox"/> Roars       | <input type="checkbox"/> Ticking | <input type="checkbox"/> Whine |
| <input type="checkbox"/> Squeaks | <input type="checkbox"/> Rattles    | <input type="checkbox"/> Scraping    | <input type="checkbox"/> Other _____ |                                  |                                |

**HOW OFTEN DOES IT OCCUR?**

- ☐ Continuous                      ☐ Often                      ☐ Intermittent                      ☐ Just started                      ☐ Since new

**WHEN DOES IT OCCUR?**

- |  |   |  |  |                                       |   |
|--|---|--|--|---------------------------------------|---|
| <input type="checkbox"/> All the time  | <input type="checkbox"/> Speed          | <input type="checkbox"/> RPM             | <input type="checkbox"/> Only moving       | <input type="checkbox"/> On turns     | <input type="checkbox"/> Braking          |
| <input type="checkbox"/> Hard throttle | <input type="checkbox"/> Light throttle | <input type="checkbox"/> Decelerate      | <input type="checkbox"/> Steady speed      | <input type="checkbox"/> Idle in gear | <input type="checkbox"/> Idle out of gear |
| <input type="checkbox"/> Hot days      | <input type="checkbox"/> Cold days      | <input type="checkbox"/> Humid or rainy  | <input type="checkbox"/> Temperature _____ |                                       |   |
| <input type="checkbox"/> Heavy bumps   | <input type="checkbox"/> Light bumps    | <input type="checkbox"/> Smooth pavement |  |                                       |   |

**EXPLAIN:** \_\_\_\_\_**CUSTOMER NAME:****PHONE NO.:****REPAIR ORDER NO:****SHOP USE ONLY:****VIN#:****MILES:****TECHNICIAN:****ADVISOR#:**

50H15062

**AIR CONDITIONING - HEATER - VENTILATION****SYSTEM OR AREA AFFECTED**

- |  |  |                                    |                                    |                                   |                                     |
|--|--|------------------------------------|------------------------------------|-----------------------------------|-------------------------------------|
| <input type="checkbox"/> Air conditioner | <input type="checkbox"/> Heater                        | <input type="checkbox"/> Defroster | <input type="checkbox"/> Vent      | <input type="checkbox"/> Bi-Level | <input type="checkbox"/> Fan/blower |
| <input type="checkbox"/> Max A/C         | <input type="checkbox"/> Automatic Temperature Control |                                    | <input type="checkbox"/> Mix/blend | <input type="checkbox"/> Economy  | <input type="checkbox"/> All        |

**SYMPTOM**

- |  |   |   |  |
|--|---|---|--|
| <input type="checkbox"/> Does not work   | <input type="checkbox"/> Blows wrong temperature air          | <input type="checkbox"/> No air comes out of vents    | <input type="checkbox"/> Rapid cycling |
| <input type="checkbox"/> Noisy (explain) | <input type="checkbox"/> Broken <input type="checkbox"/> Odor | <input type="checkbox"/> Air comes from wrong outlets | <input type="checkbox"/> Blows fuse    |
| <input type="checkbox"/> Leaks           | <input type="checkbox"/> Insufficient heat or cool            | <input type="checkbox"/> Other (explain below)        |  |

**WHEN DOES IT OCCUR?**

- |  |                              |  |                                       |  |
|--|------------------------------|--|---------------------------------------|--|
| <input type="checkbox"/> All the time              | <input type="checkbox"/> Hot | <input type="checkbox"/> Cold                  | <input type="checkbox"/> Intermittent | <input type="checkbox"/> Right after startup               |
| <input type="checkbox"/> When change controls only |                              | <input type="checkbox"/> Other (explain below) |                                       | <input type="checkbox"/> Fan blower speed High / Med / Low |

**EXPLAIN:** \_\_\_\_\_  
\_\_\_\_\_

**ELECTRICAL - RADIO - TAPE/CD PLAYER****SYMPTOM - MUSIC SYSTEM**

- |   |                                |                                     |  |                                      |   |
|---|--------------------------------|-------------------------------------|--|--------------------------------------|---|
| <input type="checkbox"/> Does not work        | <input type="checkbox"/> Noisy | <input type="checkbox"/> Static     | <input type="checkbox"/> Won't load            | <input type="checkbox"/> Won't eject | <input type="checkbox"/> Poor reception |
| <input type="checkbox"/> Controls do not work |                                | <input type="checkbox"/> Blows fuse | <input type="checkbox"/> Other (explain below) |                                      |   |

**SYSTEM AFFECTED**

- |                                      |                                    |   |   |   |
|--------------------------------------|------------------------------------|---|---|---|
| <input type="checkbox"/> Radio only  | <input type="checkbox"/> AM        | <input type="checkbox"/> FM                       | <input type="checkbox"/> FM stereo              | <input type="checkbox"/> Graphic equalizer  |
| <input type="checkbox"/> Tape player | <input type="checkbox"/> CD player | <input type="checkbox"/> Whole system             | <input type="checkbox"/> Steering wheel buttons | <input type="checkbox"/> Phone              |
| <input type="checkbox"/> Speakers    | <input type="checkbox"/> Front     | <input type="checkbox"/> Rear                     | <input type="checkbox"/> Left                   | <input type="checkbox"/> Right              |
| <input type="checkbox"/> Antenna     | <input type="checkbox"/> Clock     | <input type="checkbox"/> Radio or player controls |   | <input type="checkbox"/> Rear seat controls |

**ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES**

Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

- |       |   |                                       |  |                                  |
|-------|---|---------------------------------------|--|----------------------------------|
| _____ | <input type="checkbox"/> Inoperable                 | <input type="checkbox"/> Noisy        | <input type="checkbox"/> No control                              | <input type="checkbox"/> Erratic |
|       | <input type="checkbox"/> Check light on or flashing |                                       | <input type="checkbox"/> Works improperly (explain below)        |                                  |
|       | <input type="checkbox"/> Blows fuse                 | <input type="checkbox"/> Intermittent | <input type="checkbox"/> Related system affected (explain below) |                                  |
| _____ | <input type="checkbox"/> Inoperable                 | <input type="checkbox"/> Noisy        | <input type="checkbox"/> No control                              | <input type="checkbox"/> Erratic |
|       | <input type="checkbox"/> Check light on or flashing |                                       | <input type="checkbox"/> Works improperly (explain below)        |                                  |
|       | <input type="checkbox"/> Blows fuse                 | <input type="checkbox"/> Intermittent | <input type="checkbox"/> Related system affected (explain below) |                                  |
| _____ | <input type="checkbox"/> Inoperable                 | <input type="checkbox"/> Noisy        | <input type="checkbox"/> No control                              | <input type="checkbox"/> Erratic |
|       | <input type="checkbox"/> Check light on or flashing |                                       | <input type="checkbox"/> Works improperly (explain below)        |                                  |
|       | <input type="checkbox"/> Blows fuse                 | <input type="checkbox"/> Intermittent | <input type="checkbox"/> Related system affected (explain below) |                                  |

**WHEN DOES IT OCCUR?**

- |  |   |  |   |
|--|---|--|---|
| <input type="checkbox"/> All the time          | <input type="checkbox"/> Hot                          | <input type="checkbox"/> Cold                      | <input type="checkbox"/> Just after starting - malfunctions for a while |
| <input type="checkbox"/> Intermittent          | <input type="checkbox"/> After runs for _____ minutes | <input type="checkbox"/> Rough roads or bumps only |   |
| <input type="checkbox"/> Other (explain below) |   |  |   |

**EXPLAIN:** \_\_\_\_\_  
\_\_\_\_\_

**CUSTOMER NAME:****PHONE NO.:****REPAIR ORDER NO:****SHOP USE ONLY:**

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

## WATER LEAK - WINDNOISE

### WATER LEAK

#### Leak Occurs When?

- ☐ Setting level      ☐ Any time it rains      ☐ While driving in the rain      ☐ Car wash only  
☐ Back lower than front (facing uphill)      ☐ Front lower than back (facing downhill)

#### Location of Leak (where water appears):

- ☐ LF Door      ☐ RF Door      ☐ LR Door      ☐ RR Door      ☐ Windshield      ☐ Rear window  
☐ LF window      ☐ RF window      ☐ LR window      ☐ RR window      ☐ Side door      ☐ Sunroof/T-Top  
☐ Under instrument panel      ☐ Rear door/rear hatch

### WINDNOISE:

#### Location:

- ☐ LF Door      ☐ RF Door      ☐ LR Door      ☐ RR Door      ☐ Windshield      ☐ Rear window  
☐ LF window      ☐ RF window      ☐ LR window      ☐ RR window      ☐ Side door      ☐ Sunroof/T-Top  
☐ Under instrument panel      ☐ Rear door/rear hatch

**EXPLAIN:** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## MANUAL TRANSMISSION - CLUTCH

### SYMPTOM - MANUAL GEAR SHIFT

- ☐ Hard to shift      ☐ Doesn't shift  
☐ Grinds going into \_\_\_\_\_ gear  
☐ Noisy when in \_\_\_\_\_ gear or neutral \_\_\_\_\_  
☐ Slips/pops out of gear  
☐ Noise (describe): \_\_\_\_\_  
 \_\_\_\_\_  
☐ Upshift light stays on  
☐ Upshift light doesn't light

#### WHEN DOES IT OCCUR?

- ☐ All the time      ☐ Light load  
☐ Heavy load

**EXPLAIN:** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

### SYMPTOM - CLUTCH

- ☐ Hard to push      ☐ Fail to release  
☐ Noise when pressing pedal down (describe): \_\_\_\_\_  
 \_\_\_\_\_  
☐ Slips      ☐ Chattering (grabbing)  
☐ Odor present      ☐ Pedal stays on the floor  
☐ Squealing sound

#### WHEN DOES IT OCCUR?

##### When Engine Temperature is:

- ☐ Cold      ☐ Hot  
☐ Accelerating      ☐ Decelerating

## COMMENTS:

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**CUSTOMER NAME:**

**PHONE NO.:**

**REPAIR ORDER NO:**

**SHOP USE ONLY:**

**VIN#:**

**MILES:**

**TECHNICIAN:**

**ADVISOR#:**

Fig. 5: <sup>50.115064</sup> Symptom Check List - Page 4

## INDIVIDUAL SYSTEM-BASED CHECK LISTS

**NOTE:** Have the service adviser fill out these forms with the customer whenever possible.

**DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION**

**SYMPTOM (CHECK ALL THAT APPLY)  
ENGINE**

- ☐ "Service Engine Soon"/Malfunction Indicator Light" on
- ☐ Hard start/no start (cranks OK)
- ☐ Won't crank
- ☐ Engine stalls
- ☐ Engine miss
- ☐ Miss while driving
- ☐ Hesitates, stumbles or sags
- ☐ Rough idle
- ☐ Idle is too high ☐ Idle is too low
- ☐ Poor power/performance
- ☐ Surge or chuggle, buck - jerk - skip
- ☐ Poor gas mileage ☐ Highway ☐ City
- ☐ Ping, detonates
- ☐ Sulphur/rotten egg odor
- ☐ Backfires (popping noise) - underhood/tailpipe
- ☐ Exhaust smoke ☐ Increased oil consumption
- ☐ Runs on after key is turned off
- ☐ Speed fluctuates without moving accelerator
- ☐ Engine noise (explain): \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
(whine, rattle, groan, clunk, etc.)

☐ Other: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**TRANSMISSION**

- ☐ Does not shift properly ☐ Hard shift
  - ☐ Will not shift ☐ Up ☐ Down
  - ☐ Will not shift into overdrive
  - ☐ Engine starts in other than "P" or "N"
  - ☐ Noise (describe): \_\_\_\_\_
- \_\_\_\_\_  
\_\_\_\_\_  
(whine, rattle, groan, clunk, buzz, etc.)
- ☐ Shifts into next gear too early
  - ☐ Overdrive doesn't work with speed control, but is otherwise OK
  - ☐ Highway speed - shudder, surge, etc.
  - ☐ Other: \_\_\_\_\_

**EXPLAIN:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**OPERATING CONDITIONS (CHECK ALL THAT APPLY)  
HOW OFTEN DOES IT OCCUR? (Engine &/or Transmission)**

- ☐ Always ☐ Few Seconds ☐ Few minutes
- ☐ Few hours ☐ Few days ☐ Few weeks
- ☐ Few months ☐ Variable ☐ Only during event
- ☐ Every \_\_\_\_\_ to \_\_\_\_\_ miles ☐ Unknown
- ☐ Other (explain): \_\_\_\_\_
- ☐ Just started ☐ Getting better ☐ Getting worse
- ☐ Since new

**WHEN DOES IT OCCUR? (Engine and/or Transmission)  
When Engine Temperature is:**

- ☐ Cold ☐ Warm ☐ Hot
- ☐ All the time ☐ Only during warmup

**Weather Conditions:**

- ☐ Very cold - below 0°F ☐ Cold - 0 to 32°F
- ☐ Cool - 32 to 60°F ☐ Warm - 60 to 80°F
- ☐ Hot - above 80°F ☐ Any environment
- ☐ Raining ☐ Dry ☐ Humid
- ☐ Snow/Ice ☐ Wet roads
- ☐ Other (explain): \_\_\_\_\_

**Driving Conditions:**

- ☐ Light throttle ☐ Medium throttle ☐ Hard throttle
- ☐ Starting ☐ At idle ☐ Decelerating
- ☐ Over bumps ☐ When shifting ☐ While turning
- ☐ Cruising - steady at \_\_\_\_\_ MPH ☐ While braking
- ☐ Anytime ☐ Uphill ☐ Downhill
- ☐ Highway ☐ City/town ☐ Stop and go
- ☐ Between \_\_\_\_\_ MPH and \_\_\_\_\_ MPH
- ☐ Only with A/C or Defrost on

**What Type of Fuel?**

**What Brand?**

- ☐ Regular UL ☐ Midrange UL ☐ Premium UL
- ☐ Gasohol ☐ Ethanol ☐ Methanol
- ☐ Diesel #1 ☐ Diesel #2 ☐ Various brands

**When Gear Selector is in:**

- ☐ Park/Neutral ☐ Reverse ☐ Overdrive
- ☐ Drive/3 ☐ Drive/2 ☐ Drive/1

**Between Gears:**

- ☐ Park to R or D ☐ Reverse/Drive ☐ First/Second
- ☐ Second/Third ☐ Third/Overdrive

**CUSTOMER NAME:**

**PHONE NO.:**

**REPAIR ORDER NO.:**

**SHOP USE ONLY:**

**VIN#:**

**MILES:**

**TECHNICIAN:**

**ADVISOR#:**

50H15054

Fig. 6: Engine Driveability & Automatic Transmission

BRAKES - STEERING - SUSPENSION					
<b>SYMPTOM</b>					
<input type="checkbox"/> Vehicle pulls right - When _____	<input type="checkbox"/> Suspension bottoms out	<input type="checkbox"/> Sits uneven			
<input type="checkbox"/> Vehicle pulls left - When _____	<input type="checkbox"/> Leans or sways in corners	<input type="checkbox"/> "Dog" tracks			
<input type="checkbox"/> Steering wheel vibrates at _____ MPH	<input type="checkbox"/> Brake light on	<input type="checkbox"/> ABS light on			
<input type="checkbox"/> Excessive play in steering	<input type="checkbox"/> Traction control light on	<input type="checkbox"/> Soft ride			
<input type="checkbox"/> Erratic steering when braking	<input type="checkbox"/> Uneven tire wear				
<input type="checkbox"/> Poor steering wheel return after cornering					
<b>Hard to steer</b>		<b>Shimmy/vibration (check box below for location)</b>			
<input type="checkbox"/> Effort	<input type="checkbox"/> Wanders	<input type="checkbox"/> Front	<input type="checkbox"/> Rear	<input type="checkbox"/> Don't know	
<input type="checkbox"/> Steering wheel off center		<input type="checkbox"/> Seat	<input type="checkbox"/> Floor	<input type="checkbox"/> Other _____	
<hr/>					
<b>Brake pedal</b>					
<input type="checkbox"/> Noise	<input type="checkbox"/> Pulses	<input type="checkbox"/> Squeaks	<input type="checkbox"/> Hard	<input type="checkbox"/> Mushy	<input type="checkbox"/> Excessive travel
<b>WHEN DOES IT OCCUR?</b>					
<input type="checkbox"/> Cold days	<input type="checkbox"/> Hot days	<input type="checkbox"/> Wet/rain	<input type="checkbox"/> All the time	<input type="checkbox"/> Intermittent	
<input type="checkbox"/> Parking maneuvers	<input type="checkbox"/> At road speed	<input type="checkbox"/> Accelerating	<input type="checkbox"/> Decelerating		
<b>EXPLAIN:</b> _____					
_____					
_____					
_____					
<b>CUSTOMER NAME:</b>		<b>PHONE NO.:</b>	<b>REPAIR ORDER NO:</b>		
<b>SHOP USE ONLY:</b>					
<b>VIN#:</b>	<b>MILES:</b>	<b>TECHNICIAN:</b>	<b>ADVISOR#:</b>		

50C15059  
Fig. 7: Brakes, Steering, & Suspension

AIR CONDITIONING - HEATER - VENTILATION					
<b>SYSTEM OR AREA AFFECTED</b>					
<input type="checkbox"/> Air conditioner	<input type="checkbox"/> Heater	<input type="checkbox"/> Defroster	<input type="checkbox"/> Vent	<input type="checkbox"/> Bi-Level	<input type="checkbox"/> Fan/blower
<input type="checkbox"/> Max A/C	<input type="checkbox"/> Automatic Temperature Control	<input type="checkbox"/> Mix/blend	<input type="checkbox"/> Economy	<input type="checkbox"/> All	
<b>SYMPTOM</b>					
<input type="checkbox"/> Does not work	<input type="checkbox"/> Blows wrong temperature air	<input type="checkbox"/> No air comes out of vents	<input type="checkbox"/> Rapid cycling		
<input type="checkbox"/> Noisy (explain)	<input type="checkbox"/> Broken <input type="checkbox"/> Odor	<input type="checkbox"/> Air comes from wrong outlets	<input type="checkbox"/> Blows fuse		
<input type="checkbox"/> Leaks	<input type="checkbox"/> Insufficient heat or cool	<input type="checkbox"/> Other (explain below)			
<b>WHEN DOES IT OCCUR?</b>					
<input type="checkbox"/> All the time	<input type="checkbox"/> Hot	<input type="checkbox"/> Cold	<input type="checkbox"/> Intermittent	<input type="checkbox"/> Right after startup	
<input type="checkbox"/> When change controls only	<input type="checkbox"/> Other (explain below)		<input type="checkbox"/> Fan blower speed High / Med / Low		
<b>EXPLAIN:</b> _____					
_____					
_____					
_____					
<b>CUSTOMER NAME:</b>		<b>PHONE NO.:</b>	<b>REPAIR ORDER NO:</b>		
<b>SHOP USE ONLY:</b>					
<b>VIN#:</b>	<b>MILES:</b>	<b>TECHNICIAN:</b>	<b>ADVISOR#:</b>		

50A15057  
Fig. 8: Air Conditioning, Heater & Ventilation

## ELECTRICAL - RADIO - TAPE/CD PLAYER

### SYMPTOM - MUSIC SYSTEM

- ☐ Does not work    ☐ Noisy    ☐ Static    ☐ Won't load    ☐ Won't eject    ☐ Poor reception  
☐ Controls do not work    ☐ Blows fuse    ☐ Other (explain below)

### SYSTEM AFFECTED

- ☐ Radio only    ☐ AM    ☐ FM    ☐ FM stereo    ☐ Graphic equalizer  
☐ Tape player    ☐ CD player    ☐ Whole system    ☐ Steering wheel buttons    ☐ Phone  
☐ Speakers    ☐ Front    ☐ Rear    ☐ Left    ☐ Right  
☐ Antenna    ☐ Clock    ☐ Radio or player controls    ☐ Rear seat controls

### ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES

Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

- \_\_\_\_\_ ☐ Inoperable    ☐ Noisy    ☐ No control    ☐ Erratic  
☐ Check light on or flashing    ☐ Works improperly (explain below)  
☐ Blows fuse    ☐ Intermittent    ☐ Related system affected (explain below)
- \_\_\_\_\_ ☐ Inoperable    ☐ Noisy    ☐ No control    ☐ Erratic  
☐ Check light on or flashing    ☐ Works improperly (explain below)  
☐ Blows fuse    ☐ Intermittent    ☐ Related system affected (explain below)
- \_\_\_\_\_ ☐ Inoperable    ☐ Noisy    ☐ No control    ☐ Erratic  
☐ Check light on or flashing    ☐ Works improperly (explain below)  
☐ Blows fuse    ☐ Intermittent    ☐ Related system affected (explain below)

### WHEN DOES IT OCCUR?

- ☐ All the time    ☐ Hot    ☐ Cold    ☐ Just after starting - malfunctions for a while  
☐ Intermittent    ☐ After runs for \_\_\_\_\_ minutes    ☐ Rough roads or bumps only  
☐ Other (explain below)

EXPLAIN: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

**SHOP USE ONLY:**

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

50B15058

Fig. 9: Electrical, Radio & Tape/CD Player



**MANUAL TRANSMISSION - CLUTCH**

**SYMPTOM - MANUAL GEAR SHIFT**

- ☐ Hard to shift                      ☐ Doesn't shift  
☐ Grinds going into \_\_\_\_\_ gear  
☐ Noisy when in \_\_\_\_\_ gear or neutral \_\_\_\_\_  
☐ Slips/pops out of gear  
☐ Noise (describe): \_\_\_\_\_

- ☐ Upshift light stays on  
☐ Upshift light doesn't light

**WHEN DOES IT OCCUR?**

- ☐ All the time                      ☐ Light load  
☐ Heavy load

**EXPLAIN:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**SYMPTOM - CLUTCH**

- ☐ Hard to push                      ☐ Fail to release  
☐ Noise when pressing pedal down (describe): \_\_\_\_\_

- ☐ Slips                                      ☐ Chattering (grabbing)  
☐ Odor present                      ☐ Pedal stays on the floor  
☐ Squealing sound

**WHEN DOES IT OCCUR?**

**When Engine Temperature is:**

- ☐ Cold                                      ☐ Hot  
☐ Accelerating                      ☐ Decelerating

**CUSTOMER NAME:**

**PHONE NO.:**

**REPAIR ORDER NO:**

**SHOP USE ONLY:**

**VIN#:**

**MILES:**

**TECHNICIAN:**

**ADVISOR#:**

50J15056

Fig. 10: Manual Transmission & Clutch

### SQUEAK - RATTLE - NOISE CONDITIONS

#### AREA OF NOISE

- |  |                                  |                                      |                                 |                                     |
|--|----------------------------------|--------------------------------------|---------------------------------|-------------------------------------|
| <input type="checkbox"/> Engine Compartment    | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Front Suspension      | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Rear Suspension       | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Passenger Compartment | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Instrument Panel      | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Doors                 | <input type="checkbox"/> Left    | <input type="checkbox"/> Right       | <input type="checkbox"/> Center | <input type="checkbox"/> Don't know |
| <input type="checkbox"/> Rear seat area        | <input type="checkbox"/> Console | <input type="checkbox"/> Other _____ |                                 |                                     |

#### NOISE SOUNDS LIKE

- |                                  |                                     |                                      |                                      |                                  |                                |
|----------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|--------------------------------|
| <input type="checkbox"/> Knocks  | <input type="checkbox"/> Hard metal | <input type="checkbox"/> Light metal | <input type="checkbox"/> Roars       | <input type="checkbox"/> Ticking | <input type="checkbox"/> Whine |
| <input type="checkbox"/> Squeaks | <input type="checkbox"/> Rattles    | <input type="checkbox"/> Scraping    | <input type="checkbox"/> Other _____ |                                  |                                |

#### HOW OFTEN DOES IT OCCUR?

- |                                     |                                |                                       |                                       |                                    |
|-------------------------------------|--------------------------------|---------------------------------------|---------------------------------------|------------------------------------|
| <input type="checkbox"/> Continuous | <input type="checkbox"/> Often | <input type="checkbox"/> Intermittent | <input type="checkbox"/> Just started | <input type="checkbox"/> Since new |
|-------------------------------------|--------------------------------|---------------------------------------|---------------------------------------|------------------------------------|

#### WHEN DOES IT OCCUR?

- |  |   |  |  |                                       |   |
|--|---|--|--|---------------------------------------|---|
| <input type="checkbox"/> All the time  | <input type="checkbox"/> Speed          | <input type="checkbox"/> RPM             | <input type="checkbox"/> Only moving       | <input type="checkbox"/> On turns     | <input type="checkbox"/> Braking          |
| <input type="checkbox"/> Hard throttle | <input type="checkbox"/> Light throttle | <input type="checkbox"/> Decelerate      | <input type="checkbox"/> Steady speed      | <input type="checkbox"/> Idle in gear | <input type="checkbox"/> Idle out of gear |
| <input type="checkbox"/> Hot days      | <input type="checkbox"/> Cold days      | <input type="checkbox"/> Humid or rainy  | <input type="checkbox"/> Temperature _____ |                                       |   |
| <input type="checkbox"/> Heavy bumps   | <input type="checkbox"/> Light bumps    | <input type="checkbox"/> Smooth pavement |  |                                       |   |

EXPLAIN: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

**SHOP USE ONLY:**

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

50F15060

Fig. 11: Squeak, Rattle, & Noise Conditions

### WATER LEAK - WINDNOISE

#### WATER LEAK

##### Leak Occurs When?

- |  |  |  |  |
|--|--|--|--|
| <input type="checkbox"/> Setting level                         | <input type="checkbox"/> Any time it rains | <input type="checkbox"/> While driving in the rain               | <input type="checkbox"/> Car wash only |
| <input type="checkbox"/> Back lower than front (facing uphill) |  | <input type="checkbox"/> Front lower than back (facing downhill) |  |

##### Location of Leak (where water appears):

- |   |                                    |                                    |   |                                     |  |
|---|------------------------------------|------------------------------------|---|-------------------------------------|--|
| <input type="checkbox"/> LF Door                | <input type="checkbox"/> RF Door   | <input type="checkbox"/> LR Door   | <input type="checkbox"/> RR Door              | <input type="checkbox"/> Windshield | <input type="checkbox"/> Rear window   |
| <input type="checkbox"/> LF window              | <input type="checkbox"/> RF window | <input type="checkbox"/> LR window | <input type="checkbox"/> RR window            | <input type="checkbox"/> Side door  | <input type="checkbox"/> Sunroof/T-Top |
| <input type="checkbox"/> Under instrument panel |                                    |                                    | <input type="checkbox"/> Rear door/rear hatch |                                     |  |

#### WINDNOISE:

##### Location:

- |   |                                    |                                    |   |                                     |  |
|---|------------------------------------|------------------------------------|---|-------------------------------------|--|
| <input type="checkbox"/> LF Door                | <input type="checkbox"/> RF Door   | <input type="checkbox"/> LR Door   | <input type="checkbox"/> RR Door              | <input type="checkbox"/> Windshield | <input type="checkbox"/> Rear window   |
| <input type="checkbox"/> LF window              | <input type="checkbox"/> RF window | <input type="checkbox"/> LR window | <input type="checkbox"/> RR window            | <input type="checkbox"/> Side door  | <input type="checkbox"/> Sunroof/T-Top |
| <input type="checkbox"/> Under instrument panel |                                    |                                    | <input type="checkbox"/> Rear door/rear hatch |                                     |  |

EXPLAIN: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

**SHOP USE ONLY:**

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

50I15055

Fig. 12: Water Leak & Wind Noise

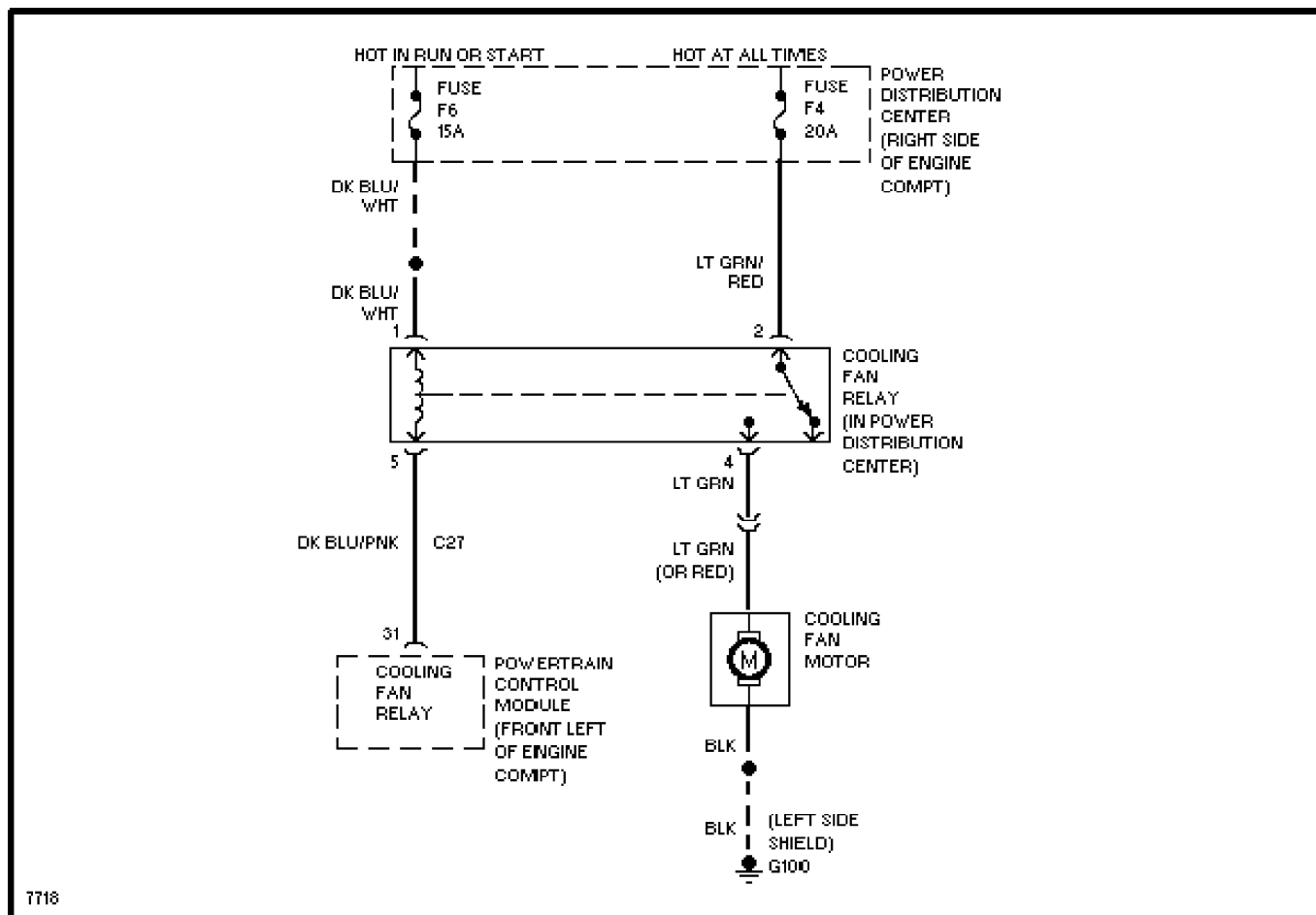


# SYSTEM WIRING DIAGRAMS

1993 Jeep Cherokee

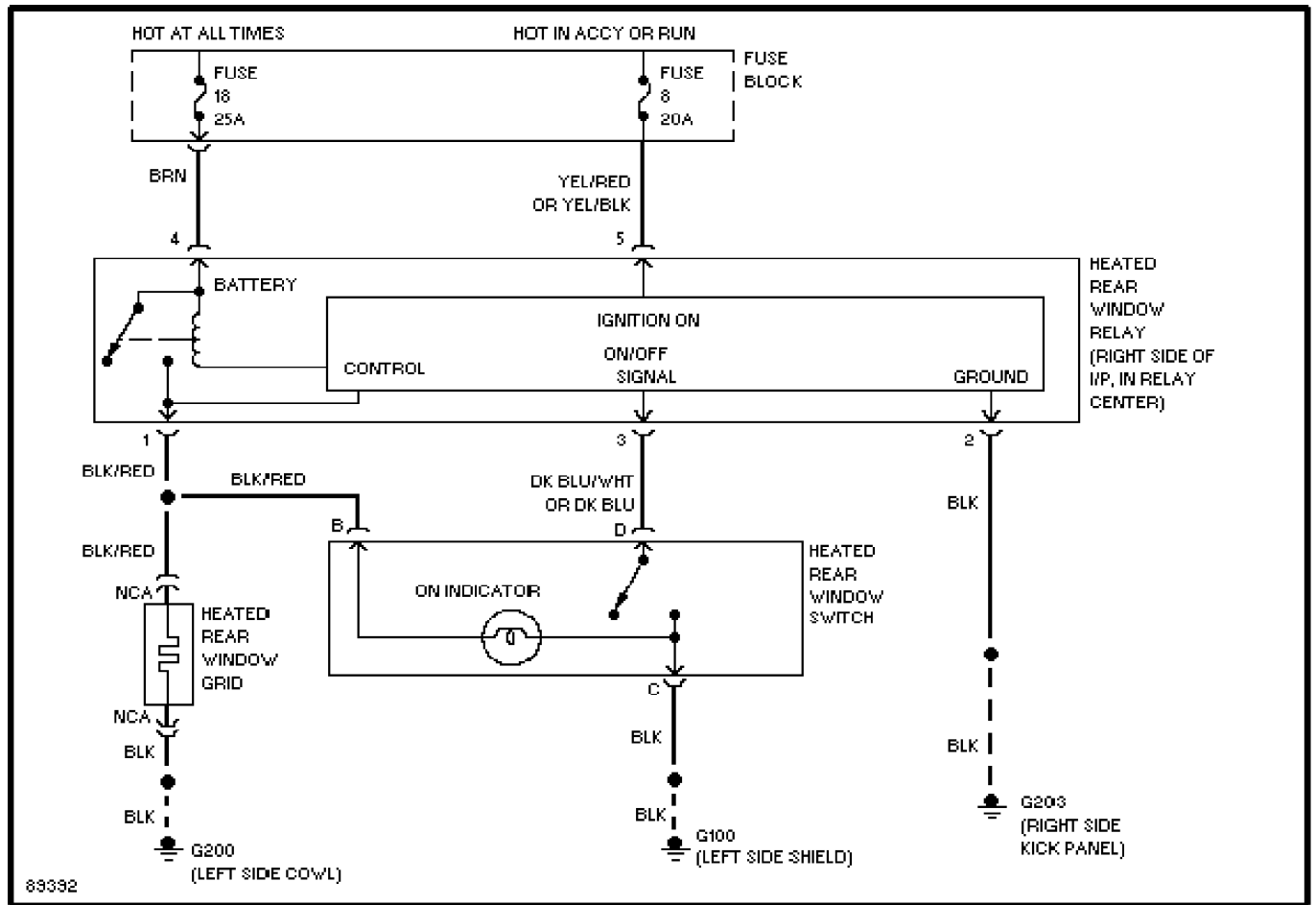
1993 System Wiring Diagrams  
Jeep - Cherokee

## COOLING FAN



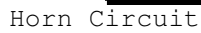
Cooling Fan Circuit

## DEFOGGERS

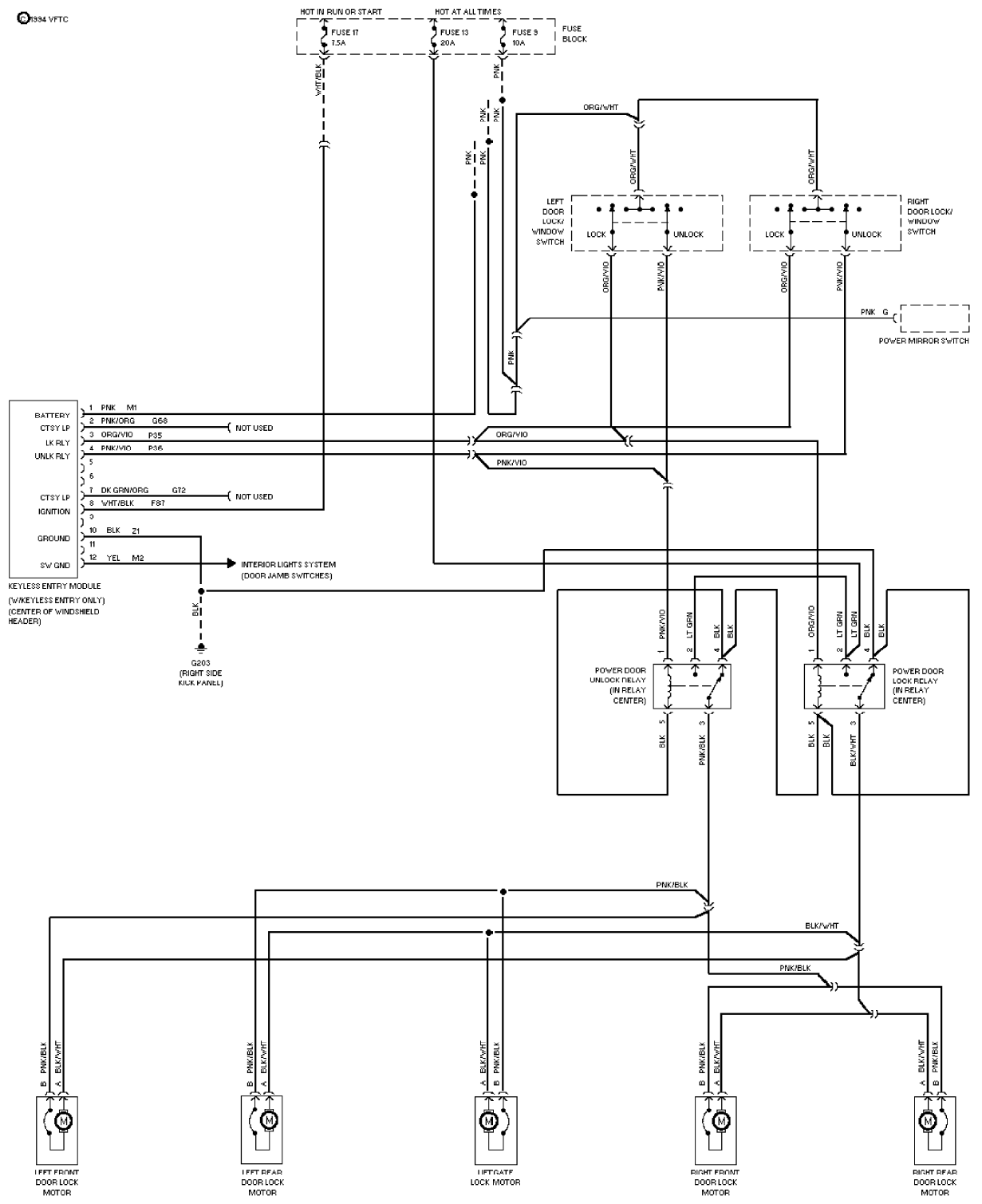


Defogger Circuit

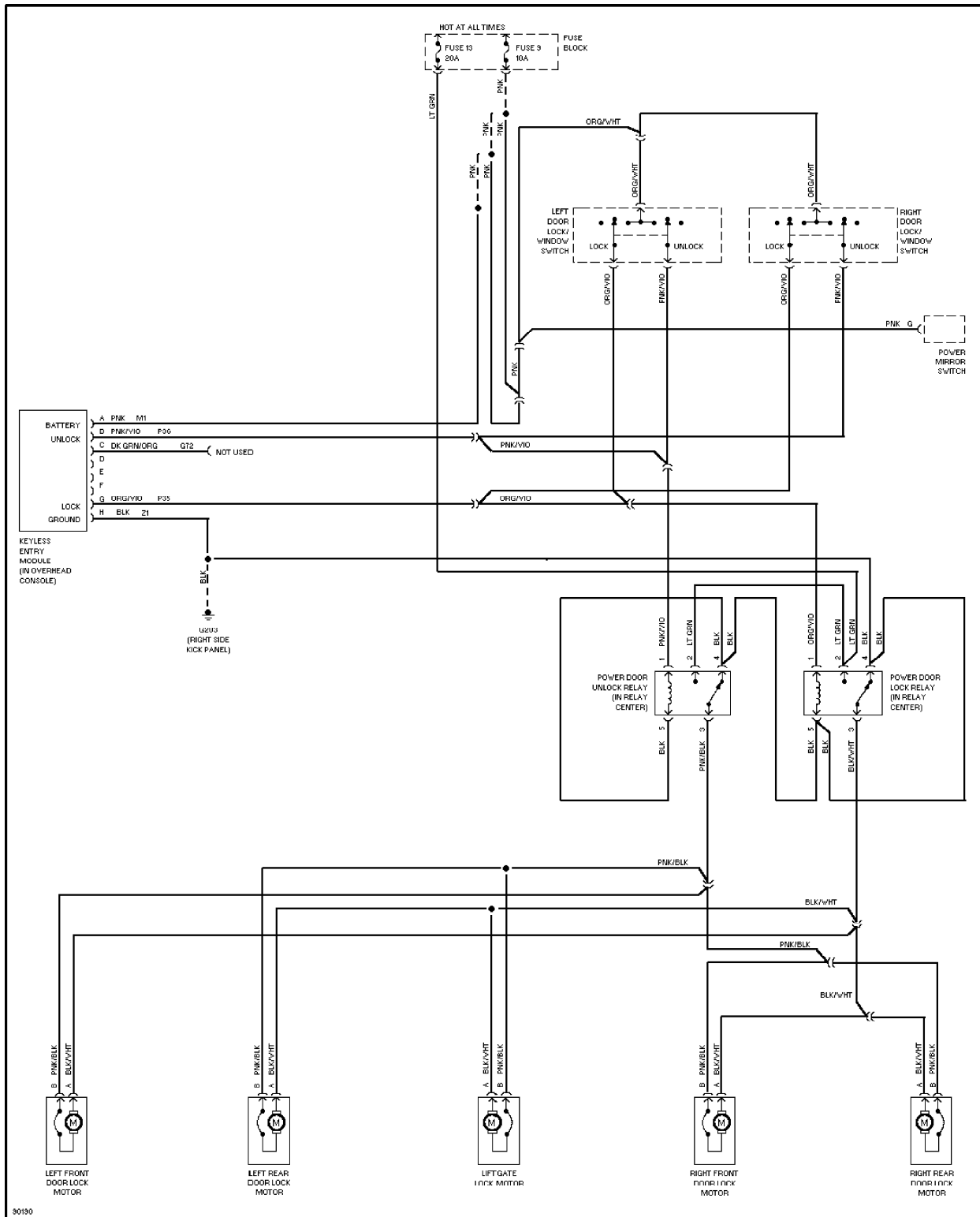
## HORN



## POWER DOOR LOCKS



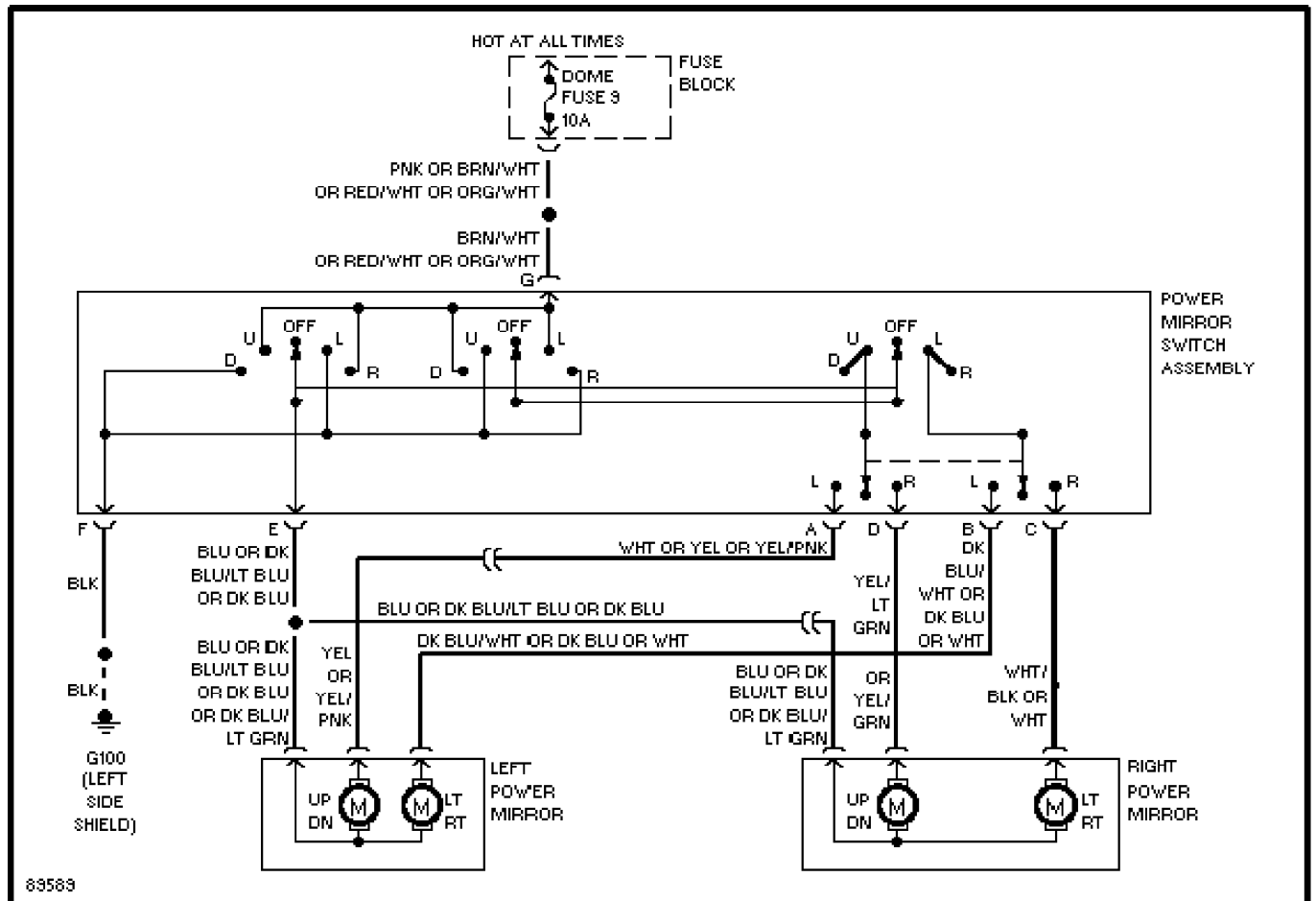
Door Lock & Keyless Entry Circuit



Power Door Lock Circuit

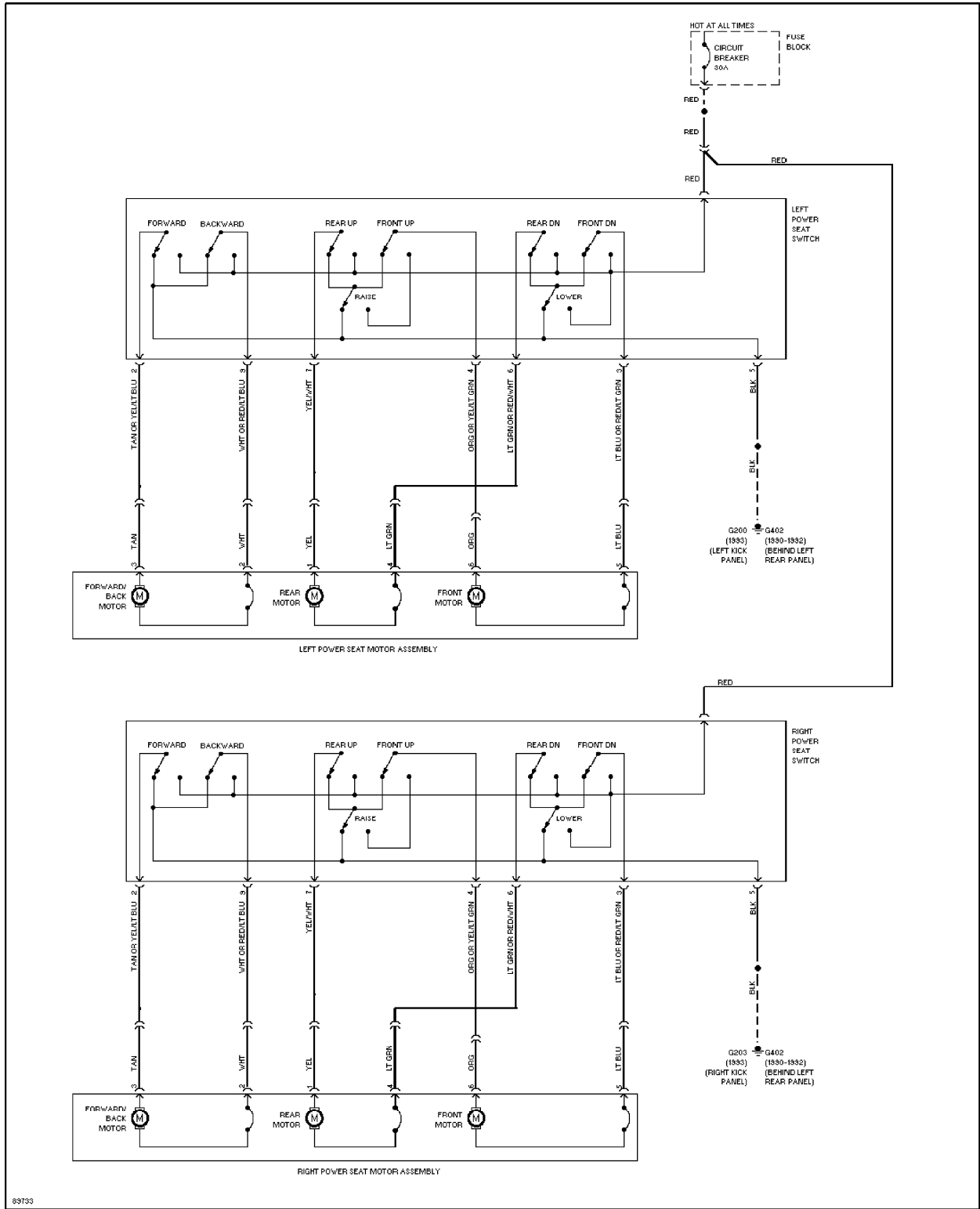
## POWER MIRRORS



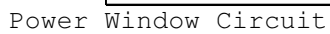


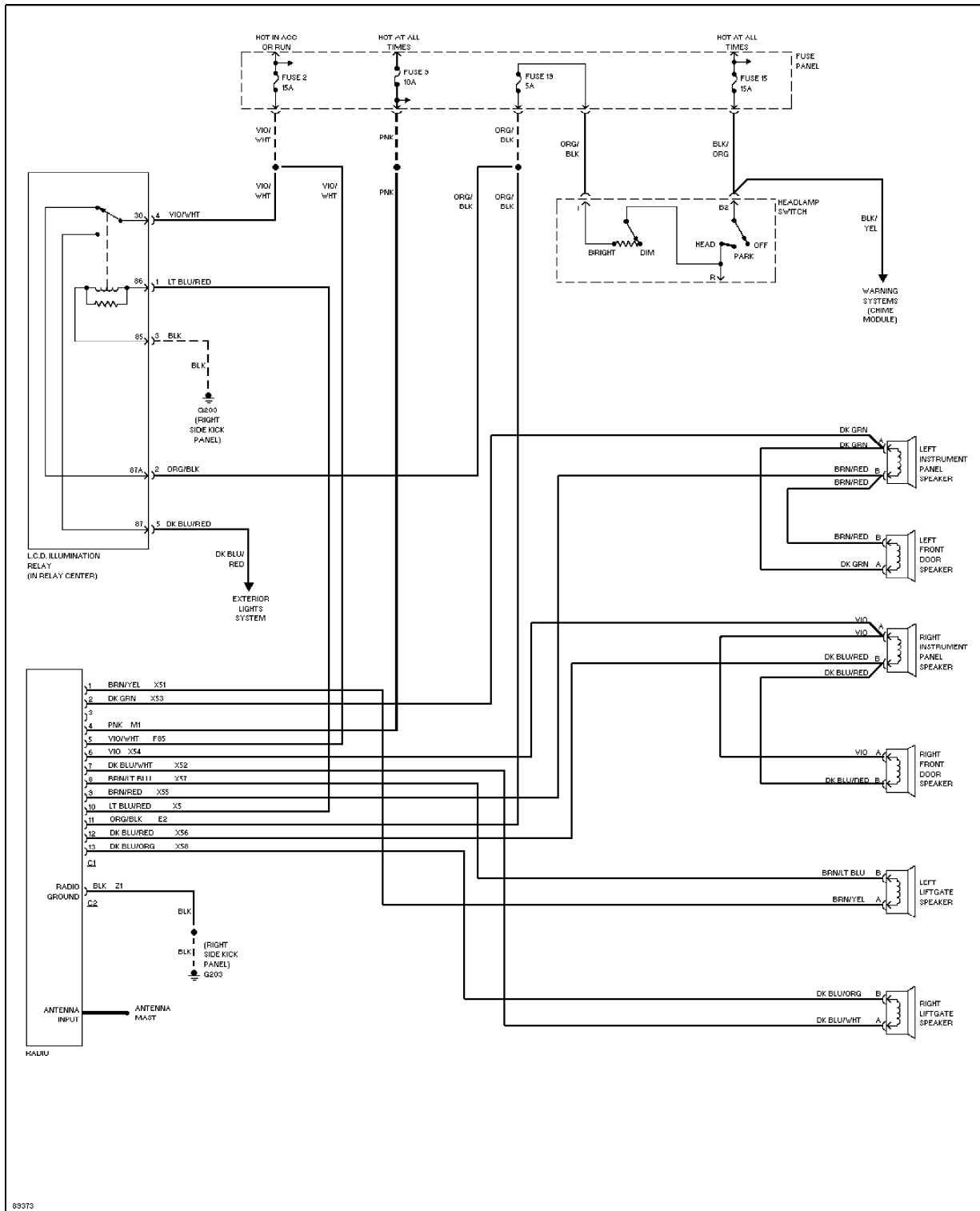
Power Mirror Circuit

## POWER SEATS



## POWER WINDOWS

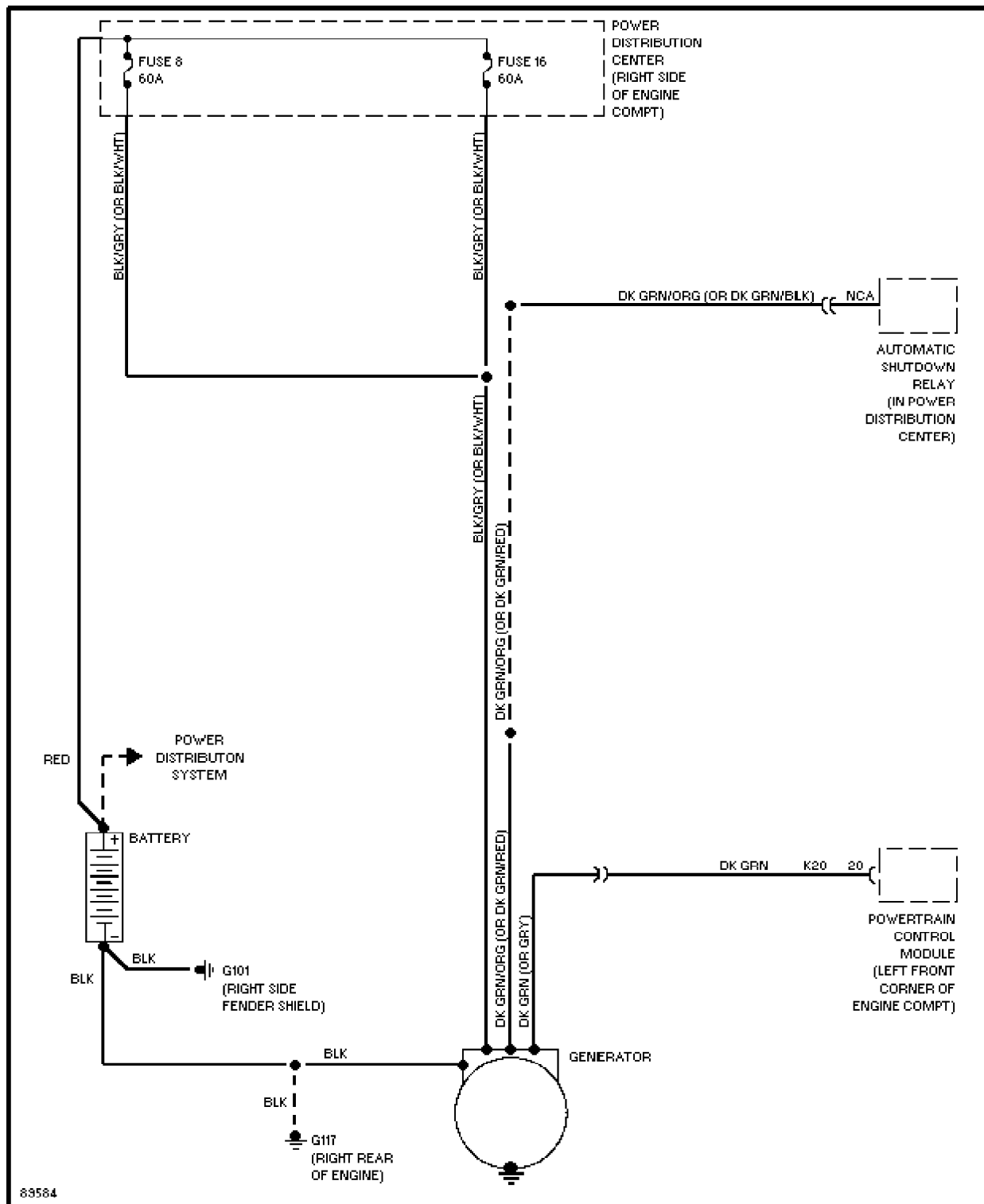




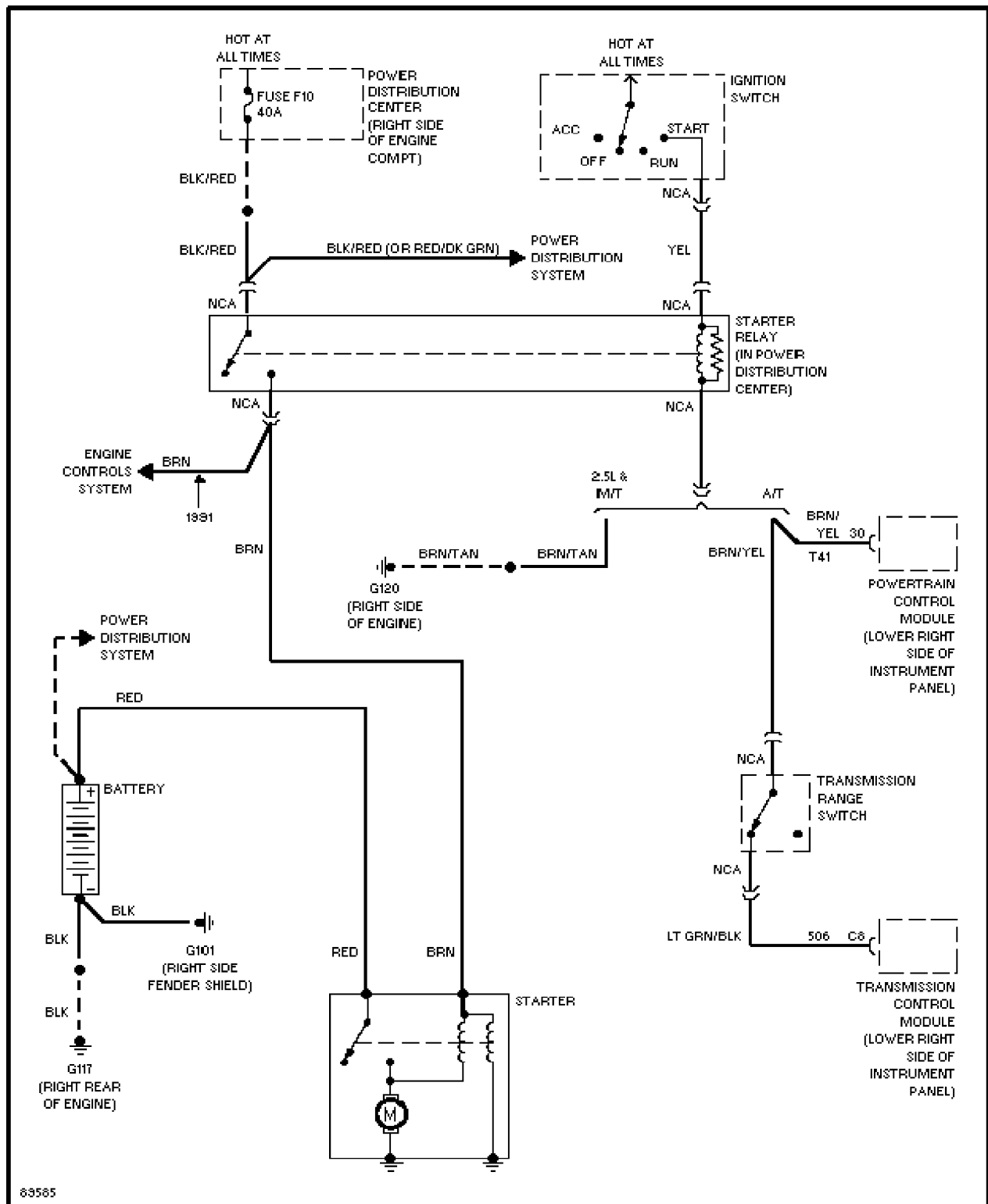
89373

Radio Circuits

**STARTING/CHARGING**

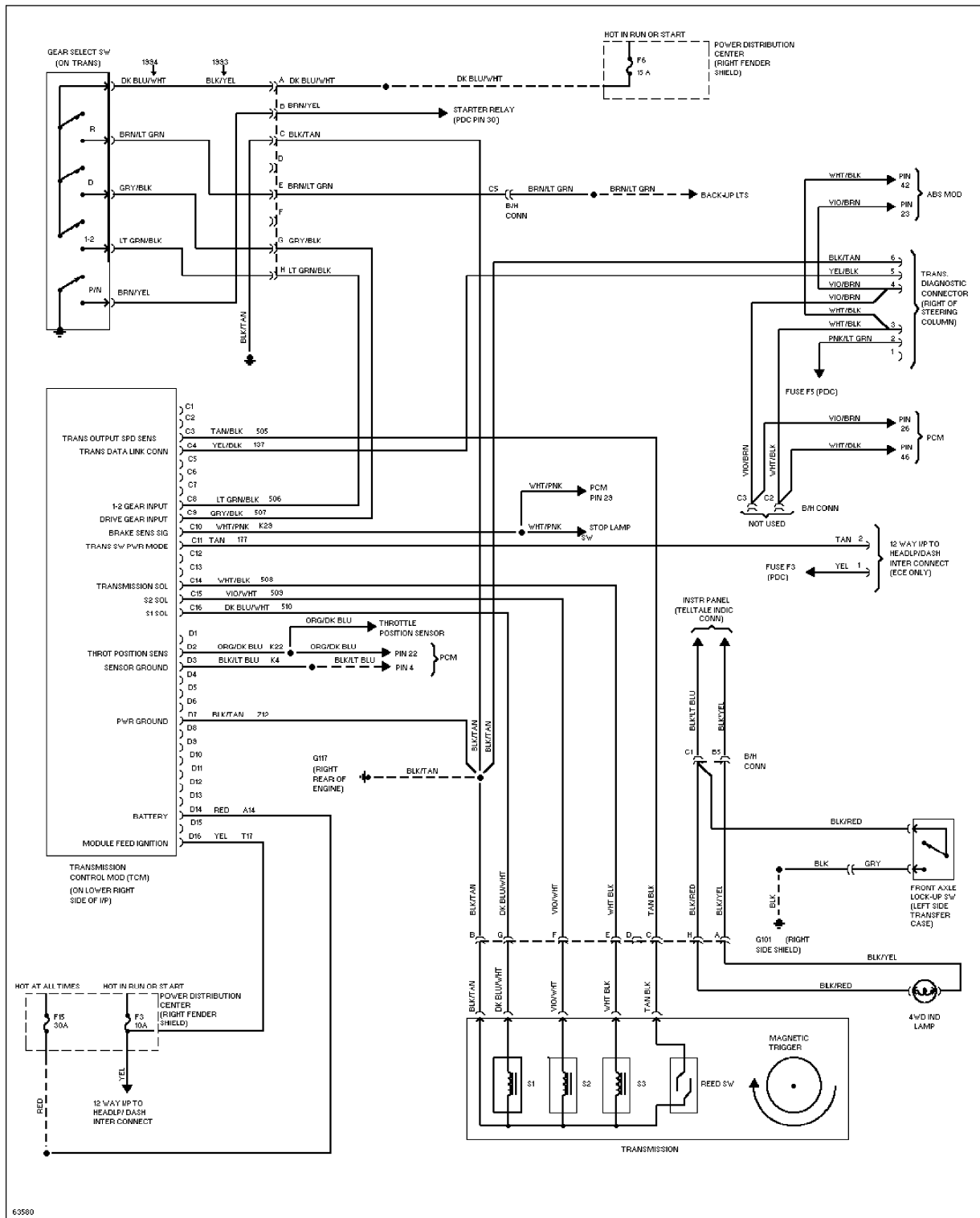


Charging Circuit



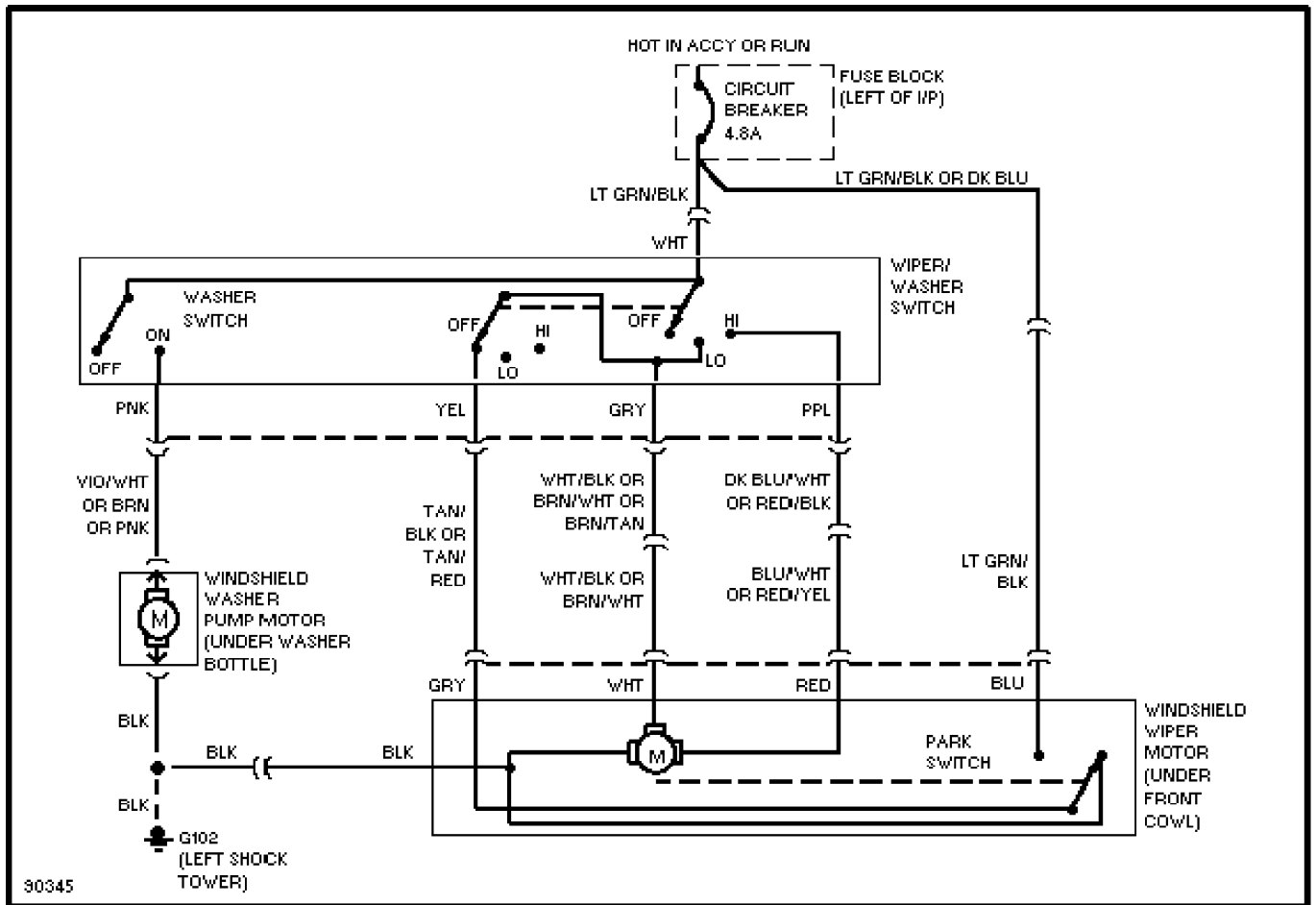
Starting Circuit

## TRANSMISSION



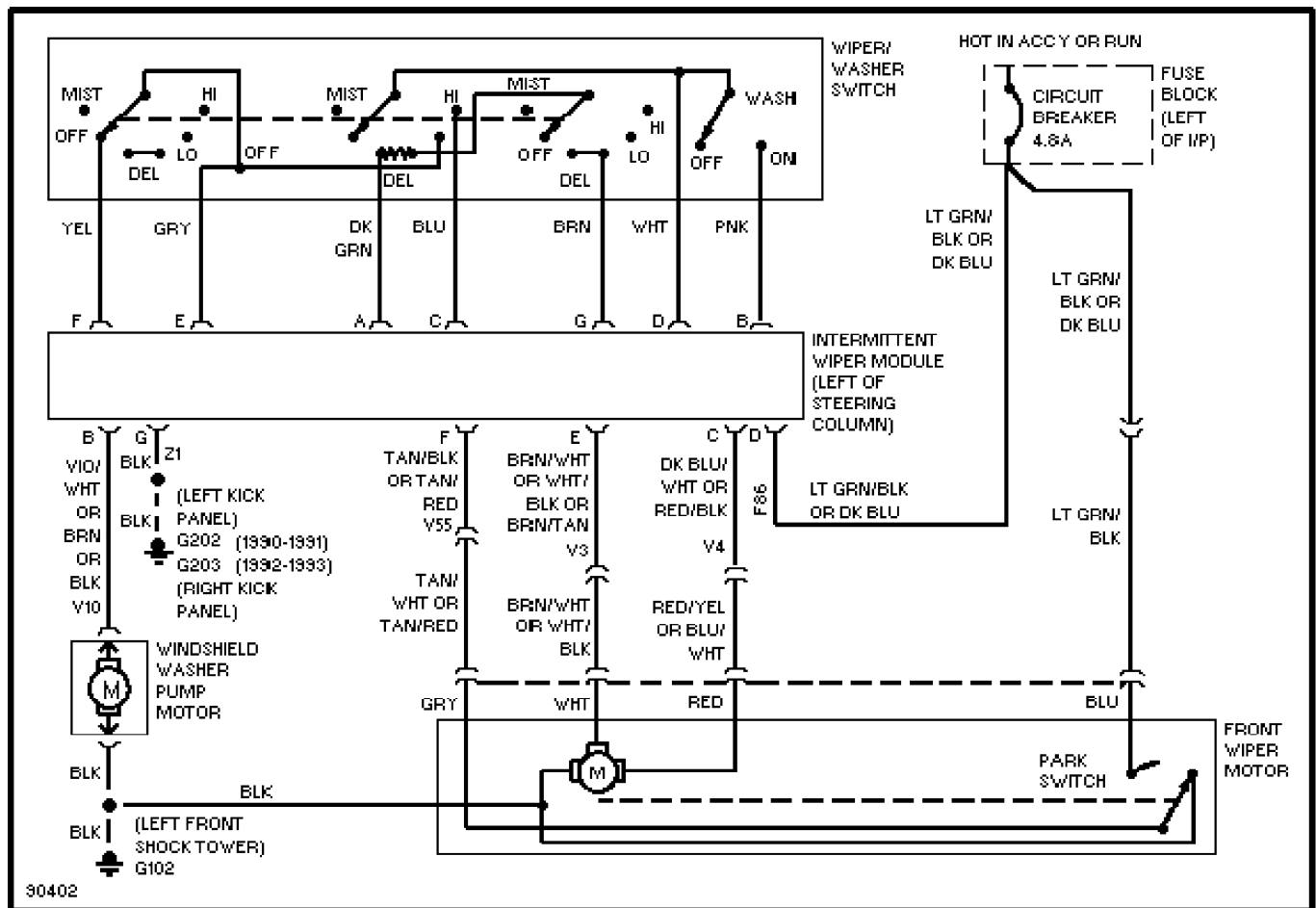
Transmission Circuit

## WIPER/WASHER

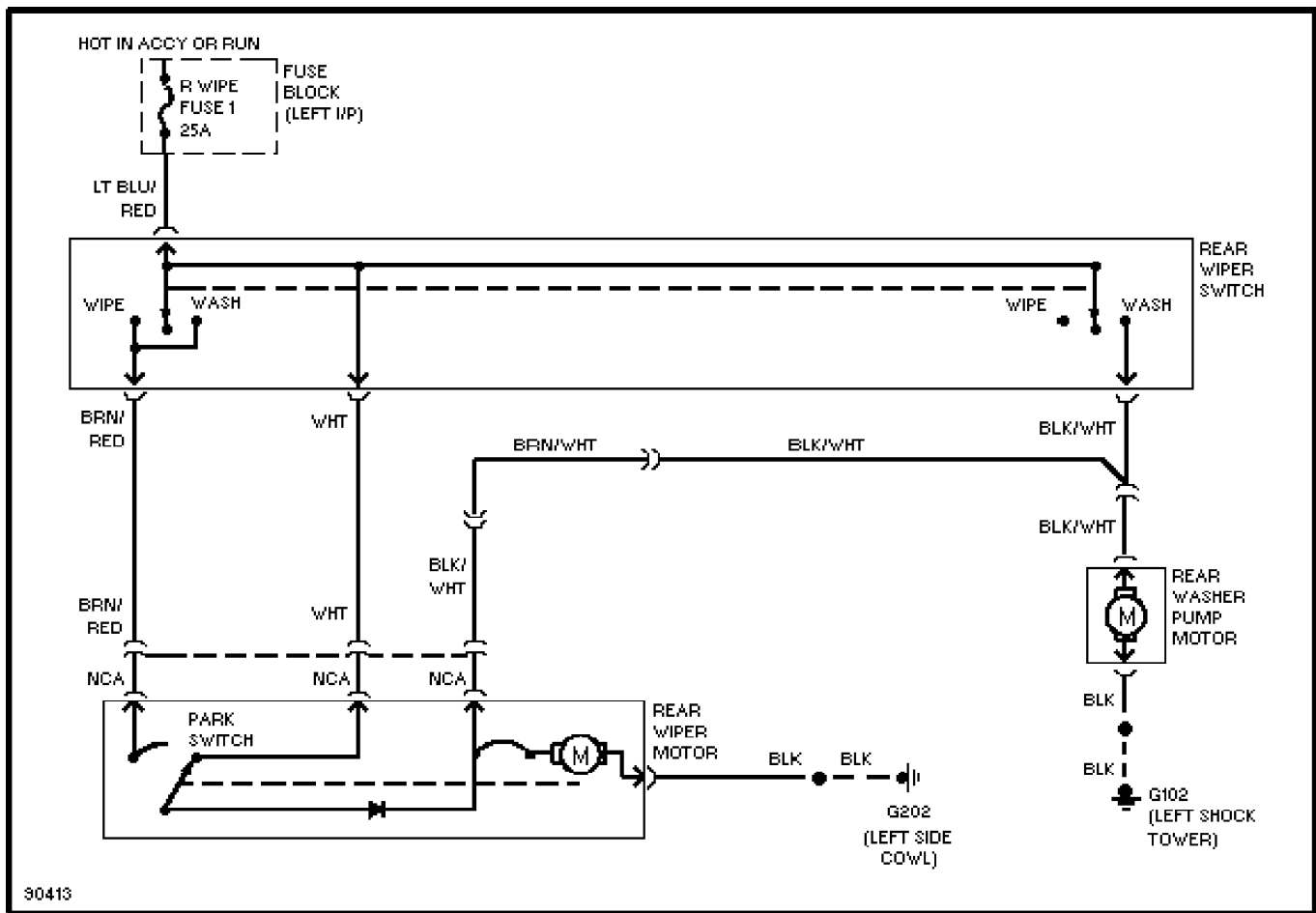


2-Speed Wiper/Washer Circuit





Interval Wiper/Washer Circuit



Rear Wiper/Washer Circuit

# TIRE/WHEEL CERTIFICATION LABEL INCORRECTLY PRINTED

1993 Jeep Cherokee

## NHTSA RECALL BULLETIN

Model(s): 1993 Jeep Cherokee  
Campaign No: 93V037000  
Number of Affected Vehicles: 3400  
Beginning Date of Manufacture: 1992 JUL  
Ending Date of Manufacture: 1992 DEC

## VEHICLE DESCRIPTION:

Utility vehicles with 4.0 liter engines.

## DESCRIPTION OF DEFECT:

The tire and wheel specification information on the certification label indicates a minimum tire size larger than the tire actually fitted to the vehicle. This does not comply with FMVSS 120, "tire selection and rims."

## FAULT:

Does not meet specs, Material, Heat treatment

## SYSTEM:

Tire certification labels; FMVSS 120.

## CONSEQUENCE OF DEFECT:

Installation of the wrong size tires to the rim could result in loss of vehicle control.

## CORRECTIVE ACTION:

Provide correct certification labels to vehicle owners for application to the vehicles.

## ADDITIONAL INFORMATION:

The National Highway Traffic Safety Administration operates Monday through Friday from 8:00 AM to 4:00 PM, Eastern Time. For more information call (800) 424-9393 or (202) 366-0123. For the hearing impaired, call (800) 424-9153.

# **TRANSFER CASE - OVERHAUL (207/231)**

## **1993 Jeep Cherokee**

1983-96 TRANSFER CASES

Chrysler Corp., GM Corp., Jeep - New Process 207 & 231

Dodge; B1500 & Dakota

GMC/Chevrolet; "T" Series (Blazer & Jimmy)

Jeep; Cherokee, Comanche, Grand Cherokee, Wagoneer, Wrangler

### **IDENTIFICATION**

Transfer case can be identified by an I.D. tag, located on rear case. I.D. tag provides model number, serial number and low range ratio. Date of manufacture is the serial number (I.D. number). This information is necessary when ordering parts.

### **DESCRIPTION**

Model 231 transfer case is a part time, chain-driven, 4-position unit with 2-piece aluminum case. Torque input in 4WD high and low range is undifferentiated. 2WD operation is achieved by a vacuum shift motor. Shift motor disconnects right front axle when 2WD is selected. Vacuum shift motor is controlled by a vacuum switch located on front of transfer case and actuated by shift sector.

### **ADJUSTMENTS**

#### **GEARSHIFT LINKAGE**

Chrysler Corp.

Shift transfer case to 2H position. Raise and support vehicle. Loosen lock bolt at trunnion. Ensure linkage rod slides freely in trunnion. Verify transfer case range lever is fully engaged in 2H position. Tighten lock bolt at trunnion. Lower vehicle. Check shift linkage operation. Ensure transfer case shifts into and operates properly in all gear ranges.

General Motors

Remove shift lever knob retainer. Remove shift lever knob. Remove floor console. Place shift lever in Neutral. Pry control cable end from shift lever. Loosen control cable lock nut. Check transfer case to ensure it is in Neutral. Ensure shift lever is in Neutral. Turn shift lever end of cable in or out as needed until it is aligned with shift lever. Install control cable on shift lever. Tighten control cable lock nut.

Jeep

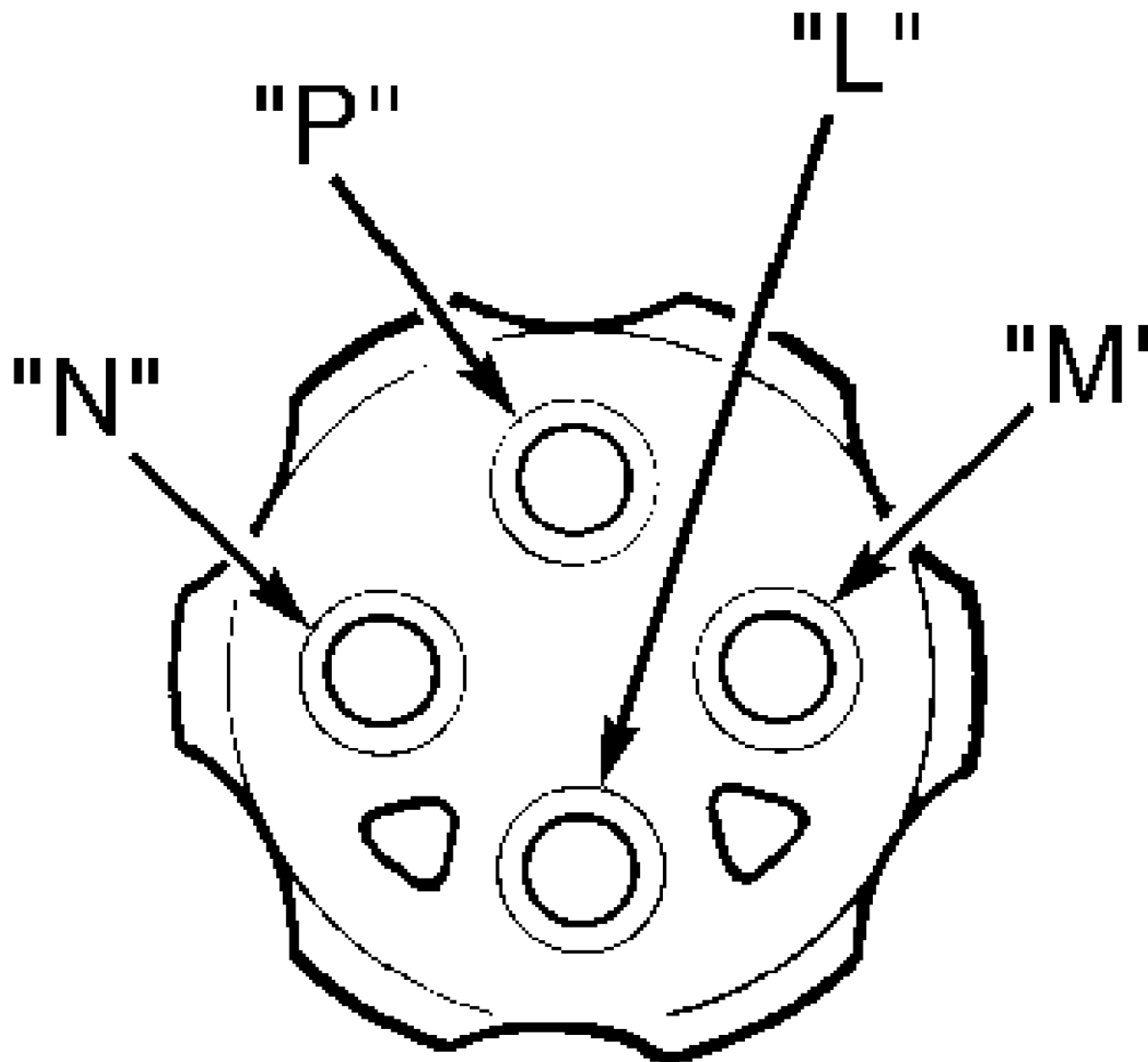
Shift transfer case to 4L position. Raise and support vehicle. Loosen lock bolt at trunnion. Ensure linkage rod slides freely in trunnion. Verify transfer case range lever is fully engaged in 4L position. Tighten lock bolt at trunnion. Lower vehicle. Check shift linkage operation. Ensure transfer case shifts into and operates properly in all gear ranges.

### **TESTING**

#### **VACUUM SWITCH**

Shift to 2WD position. Locate vacuum switch on front of

transfer case. Apply 15 in. Hg vacuum to "L". See Fig. 1. Vacuum should be present at "M". Connect a vacuum gauge to "N". Shift to 4WD position. Apply vacuum to "L". Vacuum should be present at "N". If switch fails any test, replace switch.



92F13081

Fig. 1: Testing Vacuum Switch  
Courtesy of Chrysler Corp.

**TROUBLE SHOOTING**

SYMPTOM DIAGNOSIS

Will Not Shift Or Difficult To Shift Into Gear

Vehicle speed too high; slow vehicle to 2-3 MPH to shift.  
Vehicle operated too long on dry paved surface; stop vehicle and place in Reverse or Neutral to relieve driveline torque. Ensure transfer case external linkage is not binding. Ensure correct fluid is used. Internal parts may be worn or damaged.

Noisy In All Gears

Check fluid level. Ensure correct fluid is used. If fluid is okay, locate possible internal mechanical problem.

Jumps Out Of Gear Or Noisy In 4WD

Transfer case not completely in gear; check shift linkage. Range fork damaged. Shift fork pads are worn or shift fork binding. Low range gear worn.

Fluid Leaking From Vent Or Seals

Transfer case overfilled. Vent plugged. Output shaft seals are damaged or not installed properly.

## **ON-VEHICLE SERVICE**

### **FRONT OIL SEAL**

Removal & Installation

1) Mark front drive shaft and flange for installation alignment reference. Remove front drive shaft. Remove flange. Discard washer and nut. Using a screwdriver, carefully remove oil seal. Ensure seal contact surface is clean.

2) Apply ATF to seal lip and flange seal surface. Install NEW oil seal. Install flange and NEW washer and nut. Tighten nut to specifications. See TORQUE SPECIFICATIONS. Install front drive shaft using alignment marks. Check transfer case fluid.

### **EXTENSION HOUSING OIL SEAL & BUSHING**

Removal & Installation

1) Mark rear drive shaft and flange for installation alignment reference. Remove rear drive shaft. Tap extension housing in a clockwise direction and remove extension housing. DO NOT pry on extension housing. Using a screwdriver, remove oil seal from extension housing.

2) Using bushing driver, replace bushing in extension housing. Install NEW extension housing oil seal. Apply silicone sealant to extension housing mating surface. Install extension housing. To complete installation, reverse removal procedure.

## **REMOVAL & INSTALLATION**

### **TRANSFER CASE**

Removal

1) Shift transfer case into 4H and disconnect battery negative cable. Raise vehicle, remove skid plate and drain fluid.

2) Mark front and rear output shaft yokes to drive shafts for reassembly reference. Support transfer case and remove rear crossmember. Remove drive shafts.

3) Disconnect vehicle speed sensor electrical connector and vacuum (hoses) harness at transfer case. Remove shift lever or linkage rod from case. Remove transfer case attaching bolts. Remove transfer case from vehicle.

#### Installation

1) Clean all old gasket material from transmission and transfer case mating surfaces. Position NEW gasket on transfer case with orientation tab at upper left bolt hole.

2) Install transfer case, aligning splines of input shaft with transmission. Slide transfer case forward until seated against transmission. Install transfer case attaching bolts and tighten to specification. See TORQUE SPECIFICATIONS. Install rear crossmember.

3) Attach shift lever and connect speed sensor electrical connector and vacuum harness at transfer case. Using reference marks made during removal, reinstall front and rear drive shafts. Refill transfer case. Install skid plate and lower vehicle. Connect negative battery cable. Road test vehicle.

### TRANSFER CASE DISASSEMBLY

1) Remove front companion yoke. See Fig. 2 or 3. Discard washer and nut. Shift transfer case to 4L and remove extension housing. Remove rear bearing snap ring. Using 2 screwdrivers under each tab, remove retainer housing. Remove rear case and oil pump as an assembly.

2) Remove oil pump pick-up screen and tube from rear case. Remove oil pump. Remove "O" ring from oil pump and discard. DO NOT separate oil pump halves. Pump must be replaced as an assembly if necessary.

3) Remove mode spring. Using a soft hammer, tap front output shaft upward and remove with drive chain as an assembly. Remove mainshaft, mode fork and shift rail as an assembly. Remove mode fork and shift rail from synchronizer sleeve.

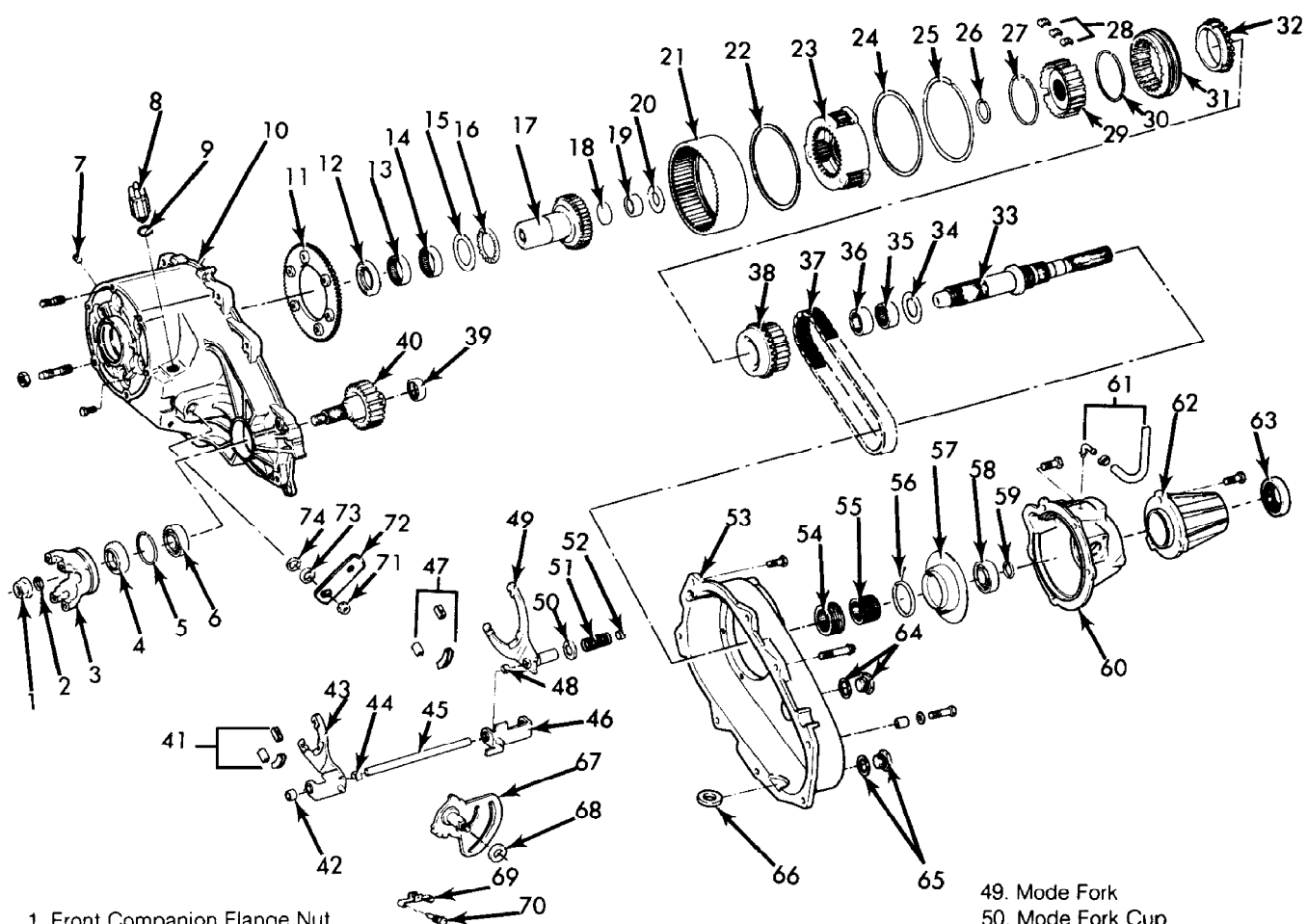
4) Mark synchronizer sleeve position for reassembly reference. Remove synchronizer sleeve from mainshaft. Remove synchronizer hub snap ring. Remove synchronizer hub, stop ring and drive sprocket. Slide range fork pin out of sector.

5) Remove range fork and shift hub as an assembly. Remove range lever from sector shaft. Remove shift sector, bushing and "O" ring. Remove shift detent pin, spring and plug. Remove front bearing retainer. Remove input gear snap ring.

6) Press input and low range gear assembly from input gear bearing. Remove low range gear snap ring. Remove input gear retainer, thrust washers and input gear from low range gear.

7) Remove all oil seals. Remove magnet from front case. Remove front bearing snap ring. Using a plastic hammer, remove front bearing. Press input gear bearing from front case.

8) Using slide hammer and internal puller, remove input gear pilot bearing. Press bearings from drive sprocket. Using internal puller and slide hammer, remove output shaft rear bearing.



1. Front Companion Flange Nut
2. Front Companion Flange Seal
3. Front Companion Flange
4. Front Output Shaft Seal
5. Snap Ring
6. Front Output Shaft Bearing
7. Case Plug
8. Vacuum Switch
9. Gasket
10. Front Case
11. Low Range Lock Plate
12. Input Gear Seal
13. Input Gear Front Bearing
14. Input Gear Rear Bearing
15. Thrust Bearing Washer
16. Input Gear Thrust Bearing
17. Input Gear
18. Input Gear Cup Plug
19. Mainshaft Pilot Bearing
20. Planetary Thrust Washer
21. Annulus Gear
22. Front Thrust Ring
23. Planetary Gear
24. Rear Thrust Ring
25. Planetary Retaining Ring

26. Snap Ring
27. Synchronizer Front Spring
28. Synchronizer Struts
29. Synchronizer Hub
30. Synchronizer Rear Spring
31. Synchronizer Sleeve
32. Synchronizer Stop Ring
33. Mainshaft
34. Thrust Washer
35. Drive Sprocket Rear Bearing
36. Drive Sprocket Front Bearing
37. Drive Chain
38. Drive Sprocket
39. Front Output Shaft Bearing
40. Front Output Shaft
41. Range Fork Pads
42. Range Fork Front Bushing
43. Range Fork
44. Range Fork Rear Bushing
45. Shift Rail
46. Shift Rail Bracket
47. Mode Fork Pads
48. Mode Fork Front Bushing

49. Mode Fork
50. Mode Fork Cup
51. Mode Fork Spring
52. Mode Fork Rear Bushing
53. Rear Case
54. Oil Pump
55. Speedometer Drive Gear
56. Pump Housing Seal
57. Oil Pump Housing
58. Mainshaft Rear Bearing
59. Rear Bearing Snap Ring
60. Rear Retainer
61. Vent Assembly
62. Extension Housing
63. Extension Housing Seal
64. Fill Plug
65. Drain Plug
66. Magnet
67. Shift Sector
68. Spacer
69. Sector Detent Spring
70. Detent Spring Bolt
71. Range Lever Nut
72. Range Lever
73. "O" Ring Retainer
74. "O" Ring

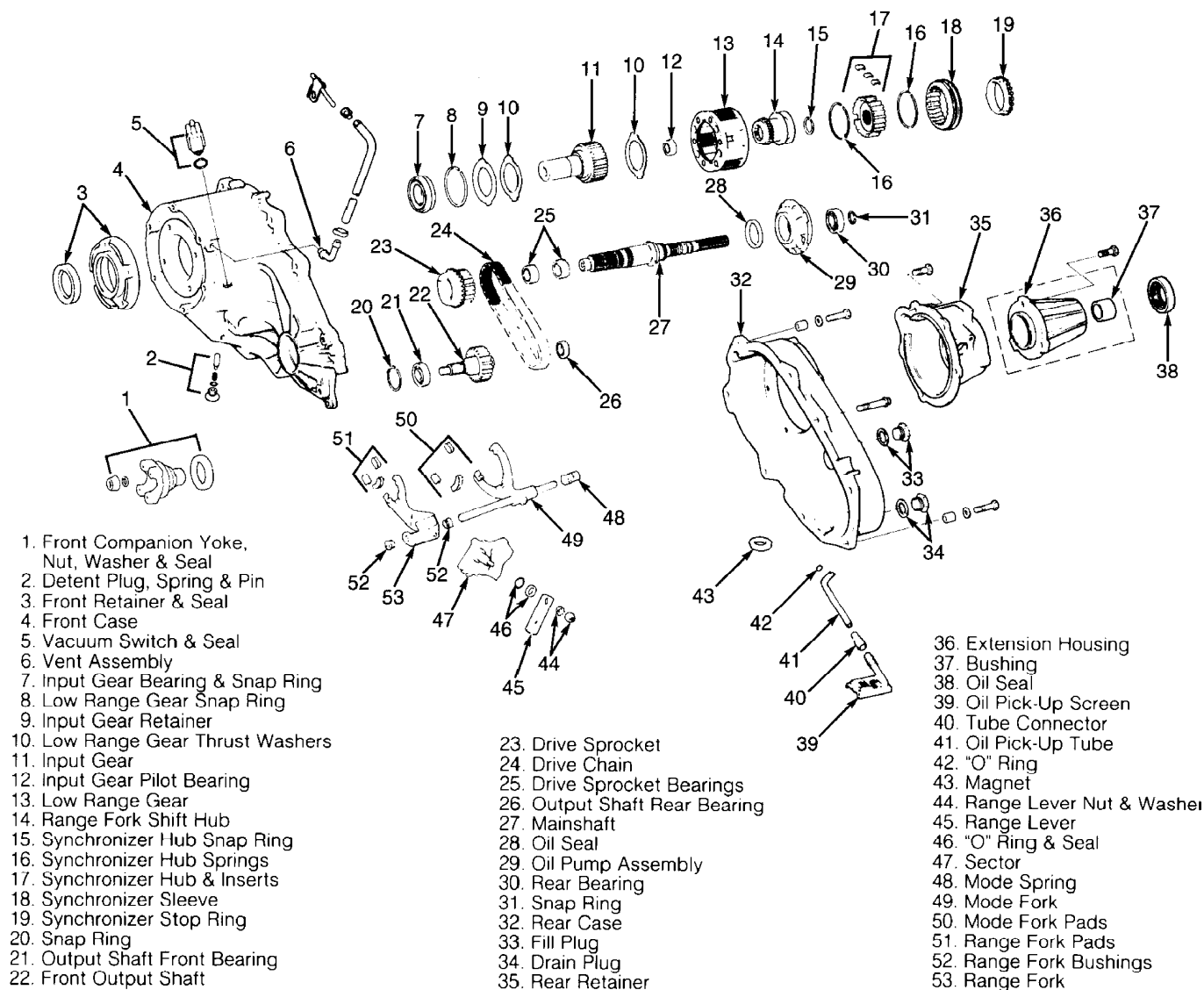
Fig. 2: Exploded View Of Transfer Case (Model 207)  
Courtesy of Chrysler Corp.

95H29410



92H13083

Fig. 3: Exploded View Of Transfer Case (Model 231)  
Courtesy of Chrysler Corp.



## CLEANING & INSPECTION

Clean all parts with solvent. Dry with compressed air. Replace all oil seals, "O" rings and snap rings. Check all parts for wear or damage. Replace all worn or damaged parts. If low range annulus gear inside front case is damaged or worn, front case and gear must be replaced as an assembly. Replace oil pump as an assembly if any part is damaged or worn.

## TRANSFER CASE REASSEMBLY

NOTE: When installing bearings, ensure bearing bores are aligned with oil feed holes.

- 1) Lubricate all parts with Dexron III before installing.

Install output shaft front bearing with NEW snap ring. Install output shaft oil seal in front case. Install snap ring on NEW input gear bearing. See Fig. 2 or 3.

2) Press input gear bearing so snap ring is seated against case. Using press, install NEW input gear pilot bearing. Assemble low range gear, input gear, thrust washers and retainer.

3) Install snap ring. Ensure snap ring is seated in low range gear groove. Start input gear shaft into bearing in front case. Press input shaft gear into bearing.

CAUTION: DO NOT press against end surfaces of gear. Failure to use proper size tool could lead to gear case or thrust washer damage.

4) Install input gear snap ring. Install oil seal in front bearing retainer. Apply a 1/8" bead of silicone sealant to retainer mating surface. Align oil channel in retainer with oil feed hole in case. Install retainer on case. Tighten bolts to specification.

5) Install sector shaft "O" ring and bushing. Install range sector in case. Install range lever and nut. Install detent, detent spring and plug. Tighten to specification. See TORQUE SPECIFICATIONS. Install NEW pads and fork rail bushings on range fork. Install range fork and shift hub.

6) Ensure range fork pin is engaged with range sector slot. Press front bearing in drive sprocket until bearing is flush with bore edge. Install rear bearing until bearing is 3/16" below bore edge. See Fig. 4.

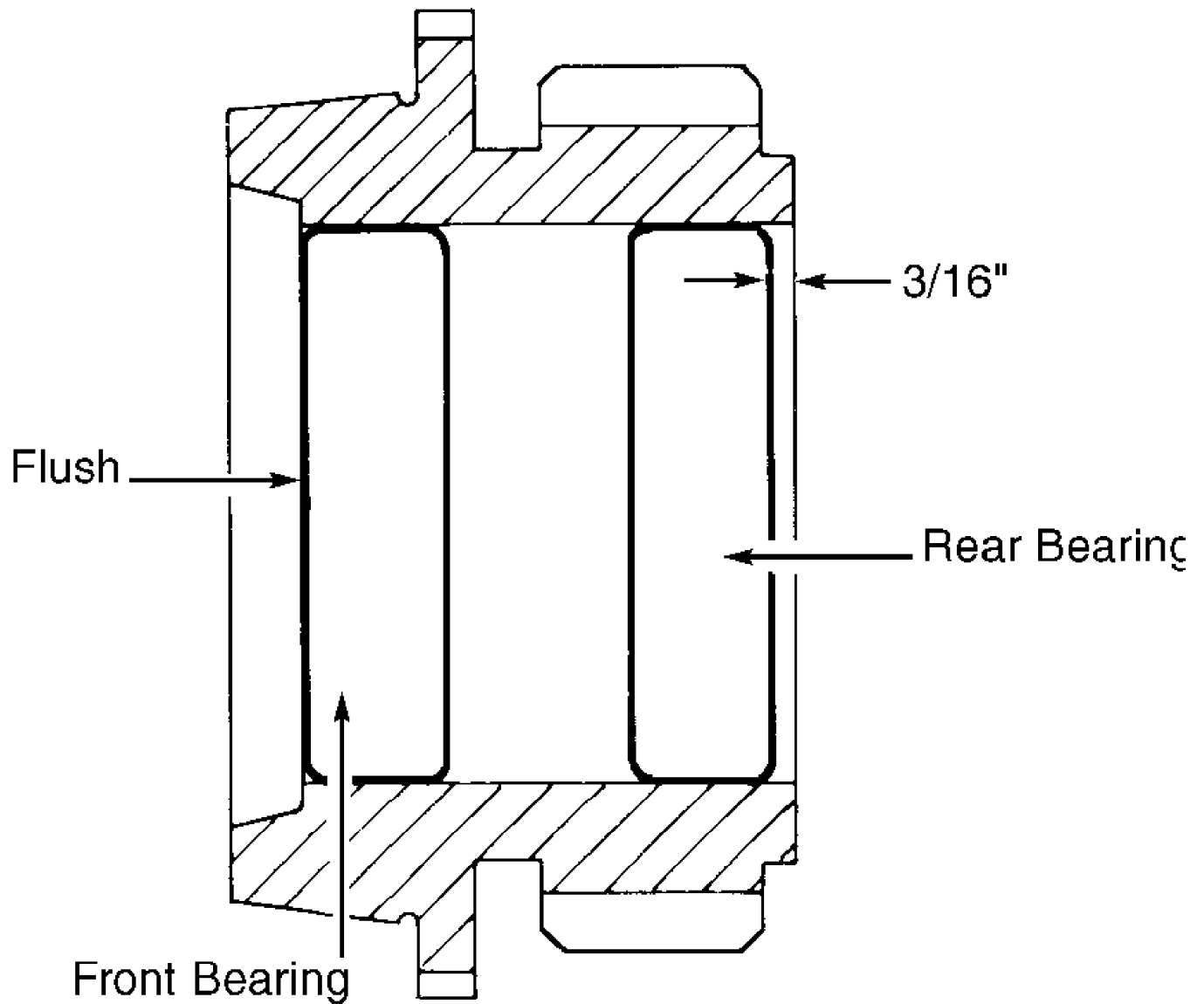
7) Install inserts and spring in synchronizer hub. Install sprocket on mainshaft. Install synchronizer stop ring on mainshaft. Ensure stop ring is seated. Install synchronizer hub on mainshaft. Align and seat hub inserts on stop ring lugs. Install synchronizer hub snap ring.

8) Install synchronizer sleeve on hub. Ensure sleeve is positioned so beveled spline ends are facing stop ring. Ensure sleeve tooth is aligned (centered) over each synchronizer strut. Gear clash will occur if strut and sleeve teeth are misaligned. Install NEW pads on mode fork. Engage mode fork in synchronizer sleeve. Install mainshaft and fork assembly in case. Ensure mode fork shift rail is seated in both range fork bushings.

9) Install output shaft and drive chain assembly. Install mode spring on shift rail. Using bearing driver, install output shaft rear bearing. Lubricate bearing after installation. Install seal in oil pump feed housing. Install oil pump in housing. Tighten to specification.

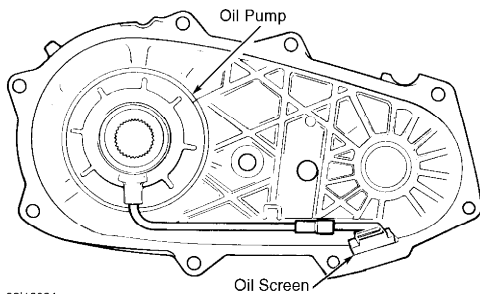
10) Install oil pick-up tube "O" ring in oil pump. Prime oil pump by pouring ATF into pump through pick-up tube opening. Install oil pump and pick-up tube in case. Ensure oil screen is properly positioned. See Fig. 5. Install magnet in front case. Apply 1/8" bead of silicone sealer to front case. Install rear case. Tighten to specification. See TORQUE SPECIFICATIONS. Ensure mainshaft splines are engaged with oil pump inner gear and a washer is used on bolts at dowel locations.

11) Install rear bearings in retainer. Apply 1/8" bead of silicone sealer and install retainer to case. Install rear retainer snap ring. Install extension housing. Install front companion yoke. Install NEW gasket on vacuum switch. Install vacuum switch in case. Fill transfer case with Dexron III.



92G13082

Fig. 4: Installing Drive Sprocket Bearings  
Courtesy of Chrysler Corp.



92I13084

Fig. 5: Identifying Oil Pump Screen Position  
Courtesy of Chrysler Corp.

## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Companion Flange Nut	
Chrysler Corp. ....	130-200 (176-271)
General Motors ....	80 (108)
Jeep ....	110 (149)
Detent Plug	
General Motors ....	11 (15)
Chrysler Corp. & Jeep ....	15 (20)
Drain & Fill Plug ....	30-40 (41-54)
Extension Housing Bolt ....	20-25 (27-34)
Front Bearing Retainer Bolt	
Chrysler Corp. & Jeep ....	16 (22)
General Motors ....	14 (19)
Front Case-to-Rear Case Bolt	
Chrysler Corp.	
Flange Head Bolt ....	35-45 (47-61)
All Other Bolts ....	20-25 (27-34)
General Motors ....	23 (31)
Jeep ....	20-25 (27-34)
Range Lever Nut ....	15-20 (20-27)
Rear Bearing Retainer Bolt ....	20-25 (27-34)
Rear Crossmember ....	30 (41)
Shift Lever Lock Bolt ....	10 (14)
Speed Sensor Bolt ....	23 (31)
Transfer Case-to-Transmission Nut ....	26 (35)
Vacuum Switch	
Chrysler Corp. ....	15-25 (20-34)
General Motors ....	17 (23)
Jeep ....	20-25 (27-34)
	INCH Lbs.
Control Cable Lock Nut ....	18 (2)

## VACUUM DIAGRAMS

For vacuum diagrams, refer to appropriate VACUUM DIAGRAMS article in the ENGINE PERFORMANCE section.

# **TRANSFER CASE - NP/NV 242**

1993 Jeep Cherokee

1987-96 TRANSFER CASES  
Jeep - New Venture 242

Cherokee, Comanche, Wagoneer, Grand Wagoneer

## **IDENTIFICATION**

Transfer case can be identified by an I.D. tag, located on rear case. I.D. tag provides model number, serial number and low range ratio. Date of manufacture is the serial number (I.D. number). This information is necessary when ordering parts.

## **DESCRIPTION**

Model 242 transfer case is a chain-driven, 2-piece aluminum case, with full time operation. Torque input in 4WD high and low range is undifferentiated.

## **ADJUSTMENTS**

### **GEARSHIFT LINKAGE**

Remove shift boot and shift to 4L position. Loosen trunnion nut. Adjust trunnion and shift rod until rod fits freely. Tighten trunnion nut and remove shim.

## **TROUBLE SHOOTING**

### **SYMPTOM DIAGNOSIS**

Will Not Shift Or Difficult To Shift Into Gear

Check fluid level. Check linkage adjustment. Ensure transfer case external linkage is not binding. Internal parts may be worn or damaged.

Noisy In All Gears

Check fluid level. Ensure correct fluid is used. If fluid is okay, locate noise and check for possible internal mechanical problem.

Jumps Out Of Gear Or Noisy In 4WD

Transfer case not completely in gear; check shift linkage. Range fork damaged. Inserts are worn. Shift fork binding on shift rail. Low range gear worn or damaged.

Fluid Leaking From Vent Or Seals

Transfer case overfilled. Vent plugged. Output shaft seals are damaged or not installed properly.

Transfer Case Will Not Shift Through High Lock Range

Incomplete shift due to driveline torque load; momentarily release accelerator pedal to complete shift. Check tire pressure and tire wear. Vehicle overloaded; remove load and check shifting.

## **ON-VEHICLE SERVICE**

### **FRONT OIL SEAL**

#### Removal & Installation

1) Mark front propeller shaft and flange for alignment purposes. Remove front propeller shaft. Remove flange. Discard washer and nut. Using a screwdriver, carefully remove oil seal. Ensure seal contact surface is clean.

2) Apply ATF to seal lip and yoke seal surface. Install oil seal and flange with new washer and nut. Install front propeller shaft using alignment marks. Check transfer case fluid.

### EXTENSION HOUSING OIL SEAL & BUSHING

NOTE: When replacing oil seal, DO NOT remove extension housing.

#### Removal & Installation

1) Mark rear propeller shaft and flange for installation purposes. Remove rear propeller shaft. Remove bolts and tap extension housing in a clockwise direction and remove extension housing. DO NOT pry on extension housing. Using a screwdriver, remove oil seal from extension housing.

2) Using bushing driver, replace bushing in extension housing. Install new extension housing oil seal. Apply silicone sealant to extension housing mating surface. Install extension housing. Reverse removal procedure to complete installation.

### REMOVAL & INSTALLATION

#### TRANSFER CASE

##### Removal & Installation

1) Shift transfer case into Neutral position and drain fluid. Mark front and rear drive shaft for installation purposes. Remove front and rear drive shafts. Disconnect vacuum lines and speedometer cable. Remove rear crossmember.

2) Disconnect shift linkage. Support transfer case with a jack. Separate transfer case from transmission. Remove transfer case. To install, reverse removal procedure. Tighten bolts to specification. See TORQUE SPECIFICATIONS. Adjust shift linkage, if necessary.

### TRANSFER CASE DISASSEMBLY

1) Remove drain and fill plugs. See Fig. 1. Remove front companion flange, washer and seal. Place transfer case in 4L position. Remove extension housing. See EXTENSION HOUSING OIL SEAL & BUSHING under ON-VEHICLE SERVICE. Remove rear bearing snap ring. Remove rear bearing retainer. Separate rear case from front case using prybars or screwdriver. DO NOT damage mating surfaces.

NOTE: DO NOT disassemble oil pump, replace as unit only.

2) Remove oil pump, pick-up tube and screen from rear case. Remove pick-up tube "O" ring from oil pump. Remove magnet from front case. Remove drive sprocket snap ring. Remove drive sprocket and drive chain.

3) Remove front output shaft. Remove shift lever from sector shaft. Remove shift detent plug, spring and plunger. Remove plug from low range fork lock pin access hole. Move shift sector until lock pin is aligned with hole. Remove lock pin with No. 1 screw extractor.

4) Remove shift rail from fork assembly. Remove mode fork and mainshaft as an assembly. Record mode sleeve position. Remove mode shift sleeve and mode fork assembly. Remove sleeve from fork. Remove

intermediate clutch shaft snap ring from mainshaft.

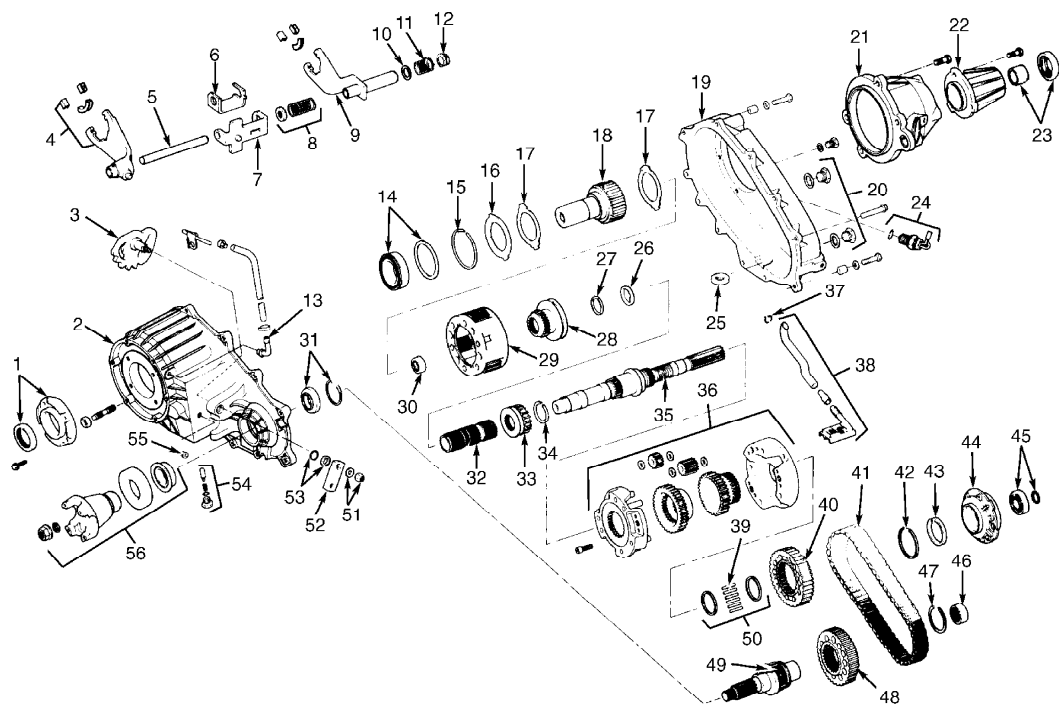
5) Remove clutch shaft thrust ring. Remove intermediate clutch shaft. Remove differential retaining snap ring. Remove differential assembly. Remove differential needle bearings and thrust washers from mainshaft. Remove low range fork and hub.

6) Remove shift sector. Remove shift sector bushing and "O" ring. Remove front bearing retainer. Remove input gear snap ring. Using a press, remove input and low range gear assembly from input gear bearing. Remove low range gear snap ring.

7) Remove input gear retainer, thrust washers and input gear. Mark differential halves for reassembly purposes. Separate differential halves. Remove planetary gear and thrust washers.

8) Record mainshaft gear and sprocket gear position. Remove gears. Remove front output shaft front bearing oil seal, snap ring and front bearing. Using a press, remove input gear bearing.

9) Using slide hammer and internal puller, remove input gear pilot bearing. Using slide hammer and internal puller, remove front output shaft rear bearing.



- |                                    |                                  |                               |                                  |
|------------------------------------|----------------------------------|-------------------------------|----------------------------------|
| 1. Front Bearing Retainer & Seal   | 16. Low Range Gear Retainer      | 31. Front Output Shaft Front  | 44. Oil Pump                     |
| 2. Front Case                      | 17. Low Range Gear Thrust Washer | Bearing & Snap Ring           | 45. Rear Bearing & Snap Ring     |
| 3. Shift Sector                    | 18. Input Gear                   | 32. Intermediate Clutch Shaft | 46. Front Output Shaft           |
| 4. Low Range Fork & Inserts        | 19. Rear Case                    | 33. Shift Sleeve              | Rear Bearing                     |
| 5. Shift Rail                      | 20. Drain & Fill Plugs           | 34. Snap Ring                 | 47. Snap Ring                    |
| 6. Shift Bracket                   | 21. Rear Bearing Retainer        | 35. Mainshaft                 | 48. Driven Sprocket              |
| 7. Slider Bracket                  | 22. Extension Housing            | 36. Differential Assembly     | 49. Front Output Shaft           |
| 8. Bushing & Spring                | 23. Bushing & Oil Seal           | 37. Oil Pick-Up Tube "O" Ring | 50. Mainshaft Bearing Spacers    |
| 9. Mode Fork & Inserts             | 24. Vacuum Switch (If Equipped)  | 38. Oil Pick-Up Tube & Screen | 51. Shift Lever Washer & Nut     |
| 10. Bushing                        | 25. Magnet                       | 39. Mainshaft Bearing Rollers | 52. Shift Lever                  |
| 11. Fork Spring                    | 26. Thrust Ring                  | 40. Drive Sprocket            | 53. Sector "O" Ring & Seal       |
| 12. Bushing                        | 27. Snap Ring                    | 41. Drive Chain               | 54. Detent Pin, Spring & Plug    |
| 13. Vent Tube                      | 28. Shift Sleeve                 | 42. Snap Ring                 | 55. Seal Plug                    |
| 14. Input Gear Bearing & Snap Ring | 29. Low Range Gear               | 43. Oil Pump Seal             | 56. Companion Flange, Nut, Seal, |
| 15. Low Range Gear Snap Ring       | 30. Pilot Bushing                |                               | Washer & Oil Slinger             |

92A13086

Fig. 1: Exploded View Of Model 242 Transfer Case  
Courtesy of Chrysler Motors.

## CLEANING & INSPECTION

1) Clean all parts with solvent. Dry with compressed air. Replace all oil seals, "O" rings and snap rings. Check all parts for wear or damage. Replace all worn or damaged parts. Apply Dexron II to all parts before installing.

2) Inspect low range annulus gear inside front case. If gear is worn or damaged, replace case and gear as an assembly. Replace oil pump as an assembly if any part is damaged or worn.

NOTE: When installing bearings, ensure bearing bores are aligned with oil feed holes.

## **TRANSFER CASE REASSEMBLY**

1) Install front output shaft front bearing, snap ring and oil seal. Install snap ring on input gear bearing. Using a wooden block and press, install input gear until snap ring is against case.

2) Install input gear pilot bearing. Assemble low range gear, thrust washers, input gear and retainer. Install low range gear snap ring. Ensure snap ring is seated properly in groove.

3) Start input gear shaft through the bearing in front case. Using a press, install input gear shaft through bearing. Ensure adapter is positioned properly before pressing shaft.

NOTE: Ensure proper size tool is used to press input gear shaft; wrong size tool can damage case and thrust washers and will move pilot bearing too far into gear bore.

4) Install input gear snap ring. Install front bearing retainer oil seal. Apply 1/8" bead of silicone sealant to front bearing retainer mating surface. Install front bearing retainer on front case. Install sector shaft "O" ring and bushing. Install shift sector.

5) Install detent pin, spring and plug. Install low range fork pads. Assemble low range fork and hub. Ensure low range fork pin is engaged in shift sector slot. Install differential sprocket gear in lower differential case. Install planet gears and new thrust washers on lower case pins.

6) Ensure thrust washers are positioned on top and bottom of each planet gear. Install mainshaft gear. Align marks on upper and lower differential case. Install bolts and tighten to specifications. See TORQUE SPECIFICATIONS. Install needle bearing spacer on mainshaft.

7) Using petroleum jelly to hold needles, install bearings on mainshaft. Install other spacer. Install differential assembly. Ensure all needle bearings are in place. Install differential snap ring. Install intermediate clutch shaft. Install thrust washer and snap ring. Install mode shift sleeve in mode fork.

8) Install mode fork assembly on mainshaft. Ensure mode shift sleeve splines engage with differential splines. Install mode fork and mainshaft assembly in case. If necessary, rotate mainshaft slightly to engage mainshaft with low range components.

9) Install mode fork pin into shift sector slot. Install shift rail. Ensure shift rail is seated in shift forks. Rotate shift sector so lock pin can be installed. Install lock pin so tapered end is in fork and rail. Install plug. Install shift lever and nut on shift sector shaft.

10) Install detent plunger, spring and plug. Install front output shaft. Install drive chain and sprocket. Install drive sprocket snap ring. Install front output shaft rear bearing.

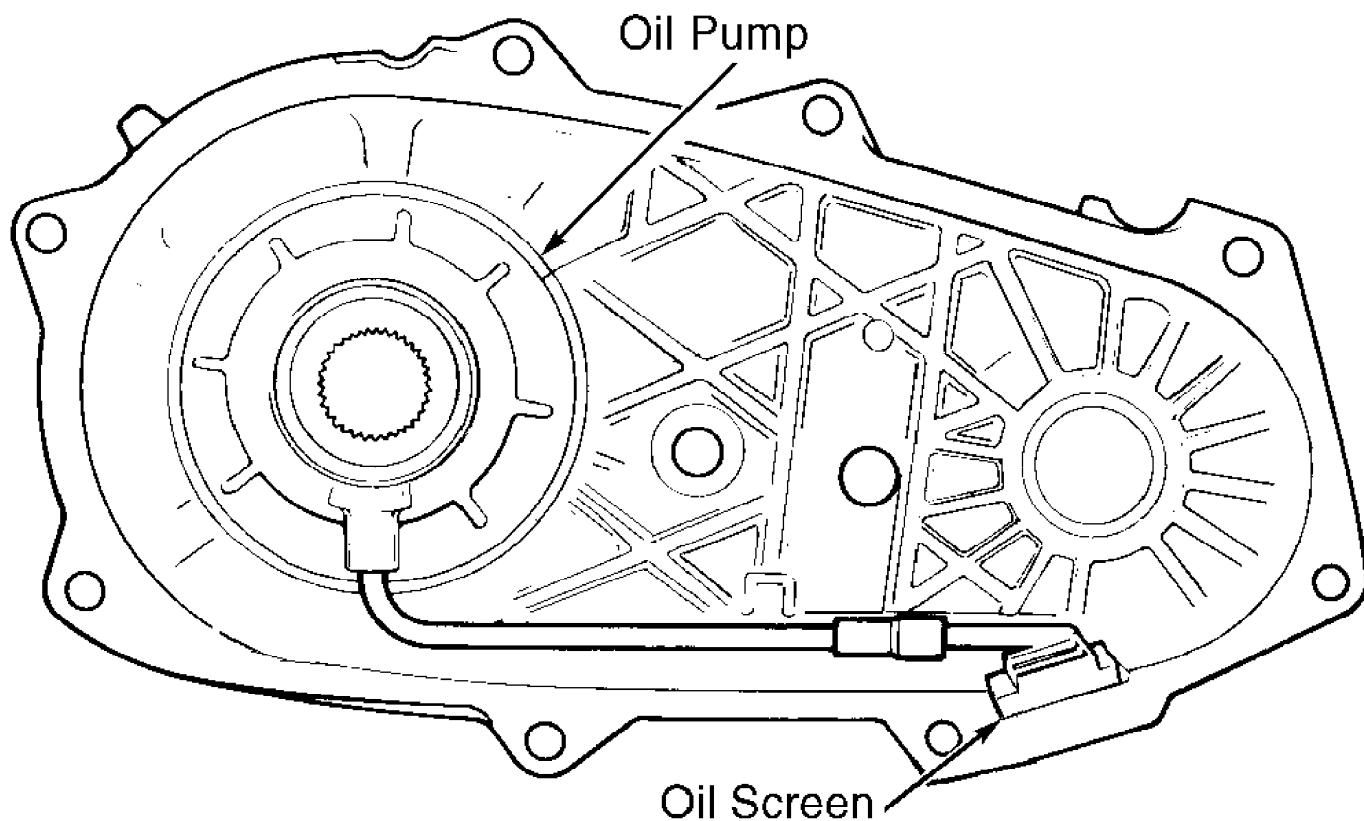
11) Install oil seal in oil pump housing. Assemble oil pump gears in housing. Ensure oil feed hole is aligned with hole in housing. Install oil pump screws. Tighten to specification. Install



"O" ring in oil pump. Install oil pick-up tube and screen. Ensure screen is properly positioned. See Fig. 2.

12) Install magnet in front case. Apply 1/8" bead of silicone sealant to front case mating surface. Assemble case halves together. Tighten to specification. Ensure mainshaft splines are engaged with oil pump inner gear and a washer is used on bolts at dowel locations.

13) Install rear retainer bearing in retainer. Apply 1/8" bead of silicone sealer and install retainer to case. Install rear bearing snap ring. Install extension housing. Install front companion flange. Install vacuum switch and drain plug. Fill transfer case with Dexron II.



92113084

Fig. 2: Identifying Oil Pump Screen Position  
Courtesy of Chrysler Motors.

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Companion Flange Nut .....	90-130 (122-176)
Detent Plug .....	14 (19)
Drain & Fill Plug .....	27 (37)
Extension Housing Bolt .....	26 (35)
Front Bearing Retainer Bolt .....	12 (16)
Front Case-to-Rear Case Bolt .....	26-34 (35-46)
Shift Fork Set Screw .....	15 (20)
Transfer Case-to-Transmission .....	26 (35)



# TRANSMISSION REMOVAL & INSTALLATION - A/T

1993 Jeep Cherokee

1993 TRANSMISSION SERVICING  
Chrysler Corp. Transmission Removal & Installation  
Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## MANUAL TRANSMISSION

NOTE: For manual transmission replacement procedures, see appropriate article in CLUTCHES.

## AUTOMATIC TRANSMISSION

### REMOVAL & INSTALLATION - EXCEPT WRANGLER

#### Removal

- 1) Raise vehicle. Drain fluid and remove upper half of transmission fill tube.
- 2) Disconnect cooler lines at transmission. Press fitting release tabs and pull cooler line and fitting out of case. Plug all openings to prevent fluid loss and contamination. Support engine with safety stand.
- 3) Support transmission/transfer case assembly with jack. Disconnect or remove following: transmission and transfer case shift linkage; necessary exhaust components; speedometer cable; transmission wiring harnesses; transfer case vacuum and wiring harnesses.
- 4) Mark drive shafts for reassembly. Disconnect drive shafts at transfer case and wire to frame rails. DO NOT allow drive shafts to hang free as damage to universal joints may result. Remove rear crossmember. Disconnect necessary vacuum and fluid hoses and transmission throttle cable at engine.
- 5) Remove crankshaft position sensor. Remove starter. Remove converter-to-drive plate and converter housing-to-engine bolts.
- 6) Secure transmission (and transfer case assembly on 4WD models) to transmission jack with safety chains. Remove transmission/transfer case assembly.

NOTE: Remove transfer case from transmission if transmission is to be overhauled.

#### Installation

- 1) To install, reverse removal procedure. On 4WD models, connect transfer case shift linkage and vacuum hoses. Install new "O" ring seal on upper half of transmission fill tube. Connect upper and lower tube halves.
- 2) Tighten all bolts to specification and fill transmission with MOPAR Mercon Type ATF fluid. See TORQUE SPECIFICATIONS TABLE at the end of this article.

### REMOVAL & INSTALLATION - WRANGLER

#### Removal

- 1) Disconnect fan shroud and transmission fill tube upper bracket. Raise vehicle. Remove converter inspection cover and fill tube. Plug fill tube hole to prevent fluid loss and contamination. Remove starter.
- 2) Mark drive shafts for reassembly. Disconnect drive shafts at transfer case and wire to frame rails. DO NOT allow drive shafts to hang free as damage to universal joints may result. Disconnect exhaust

pipes from exhaust manifolds, if necessary. Drain transfer case lubricant. Disconnect speedometer cable from transmission.  
 3) Disconnect all shift and throttle linkages and wiring from transmission and transfer case. Mark converter drive plate and converter for reassembly. Remove torque converter-to-drive plate bolts. Rotate crankshaft to gain access to bolts.  
 4) Support transmission/transfer case assembly with jack and secure with chain. Remove bolts and rear transmission crossmember. Lower transmission enough to disconnect cooler lines at transmission. Remove transmission-to-engine retaining bolts. Slowly slide transmission assembly from engine.  
 5) Hold converter in position while lowering transmission assembly from vehicle. Separate transmission from transfer case.

Installation  
 To install, reverse removal procedure. DO NOT tighten exhaust pipe attaching bolts until crossmember has been installed and transmission jack has been removed. Ensure all index marks made at removal are aligned. Tighten all bolts to specification and fill transmission and transfer case with fluid.

## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Except Wrangler	
Converter Housing Bolts	
10 mm .....	25 (34)
12 mm .....	42 (57)
Dust Cover Bolts .....	13-17 (18-23)
Filler Tube Bracket Bolt .....	37-47 (50-64)
Torque Converter-To-Drive Plate Bolts .....	22 (30)
Transfer Case-To-Transmission Bolts .....	22-30 (30-41)
Transmission-To-Engine Bolts .....	37-47 (50-64)
Transmission-To-Rear Mount Bolts .....	44-66 (60-89)
Wrangler	
Cooler Line Nut .....	13 (18)
Drive Plate-To-Converter Bolts .....	22 (30)
Drive Plate-To-Crankshaft Bolts .....	55 (75)
Filler Tube Bracket Bolt .....	24 (33)
Transfer Case-To-Transmission Bolts .....	22-30 (30-41)
Transmission-To-Engine Bolts .....	30 (41)

# TRANSMISSION SERVICING - A/T

1993 Jeep Cherokee

TRANSMISSION SERVICING  
Chrysler Corp. Automatic Transmission

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## IDENTIFICATION

### JEEP AUTOMATIC TRANSMISSION APPLICATIONS TABLE

Model	Transmission
Except Wrangler .....	Aisin Warner AW-4
Wrangler .....	Chrysler 32RH (Formerly A-999)

## LUBRICATION

### SERVICE INTERVALS

Transmission  
Check fluid level and condition of fluid at 7500 mile intervals. Change fluid, replace filter and adjust bands at 30,000 miles or 30 month intervals.

Transfer Case  
Check transfer case fluid every 7500 miles and replace fluid every 30,000 miles or 30 month intervals.

### CHECKING FLUID LEVEL

Transmission  
Park vehicle on a level surface and apply parking brake. With engine idling at normal operating temperature, move transmission selector lever through all gears, ending in Neutral (Park for AW-4 transmission). Check fluid level. Fluid level should be between FULL and ADD mark on dipstick. Add fluid as needed. DO NOT overfill.

Transfer Case  
Remove fill plug. Check oil level. If level is not up to bottom of fill plug opening, add lubricant.

### RECOMMENDED FLUID

Transmission  
Aisin Warner AW-4 transmissions and transfer cases use Mercon type ATF. Chrysler 32RH transmissions use Dexron-II type ATF.

Transfer Case  
Transfer cases use same fluid as attached transmission.

### FLUID CAPACITY

NOTE: Transmission and converter capacities are approximate. Always determine fluid level by reading on dipstick, rather than amount of fluid added. See appropriate REFILL CAPACITIES table.

### TRANSMISSION REFILL CAPACITIES TABLE

Application	Qts. (L)
AW-4 .....	8.5 (8.0)
32RH .....	8.0 (7.6)

#### TRANSFER CASE REFILL CAPACITIES TABLE

Application	Pts. (L)
Model 231 .....	3.3 (1.5)
Model 242 .....	3.0 (1.4)
Model 249 .....	3.0 (1.4)

## DRAINING & REFILLING

### Transmission

1) Position large drain pan under transmission. Loosen oil pan bolts, tap pan to break it loose and allow fluid to drain. Remove pan and oil filter. Install NEW filter on bottom of valve body and tighten retaining screws to 35 INCH lbs. (4 N.m). Clean oil pan and install with NEW gasket. Tighten bolts to 150 INCH lbs. (17 N.m).

2) Refill transmission with approximately 5 qts. (4.7L) of ATF. Start engine and allow to run at curb idle. With vehicle on level surface, engine idling and parking brake applied, move shift selector lever through all gear ranges, ending in Neutral (Park for AW-4 transmission).

3) Recheck fluid level when transmission reaches normal operating temperature. Add fluid to FULL mark on dipstick.

### Transfer Case

Remove drain plug from transfer case. Remove fill plug for easier draining. With fluid fully drained, reinstall drain plug. Fill transfer case and install fill plug. Tighten drain plug and fill plug to 20 ft. lbs. (27 N.m).

## ADJUSTMENTS

NOTE: Bands on the AW-4 transmission are not adjustable. If slippage occurs, bands must be replaced.

### KICKDOWN (FRONT) BAND

#### 32RH

1) Locate kickdown band adjusting screw on left side of case (near throttle lever shaft). See Fig. 1. Loosen adjusting screw lock nut and back off 4-5 turns. Ensure adjusting screw turns freely in case.

2) Tighten adjusting screw to 72 INCH lbs. (8 N.m). If Adapter Extension (J-24063) is used, tighten adjusting screw to 50 INCH lbs. (5 N.m). Back off adjusting screw 2 1/2 turns. Hold adjusting screw and tighten lock nut to 30 ft. lbs. (41 N.m).

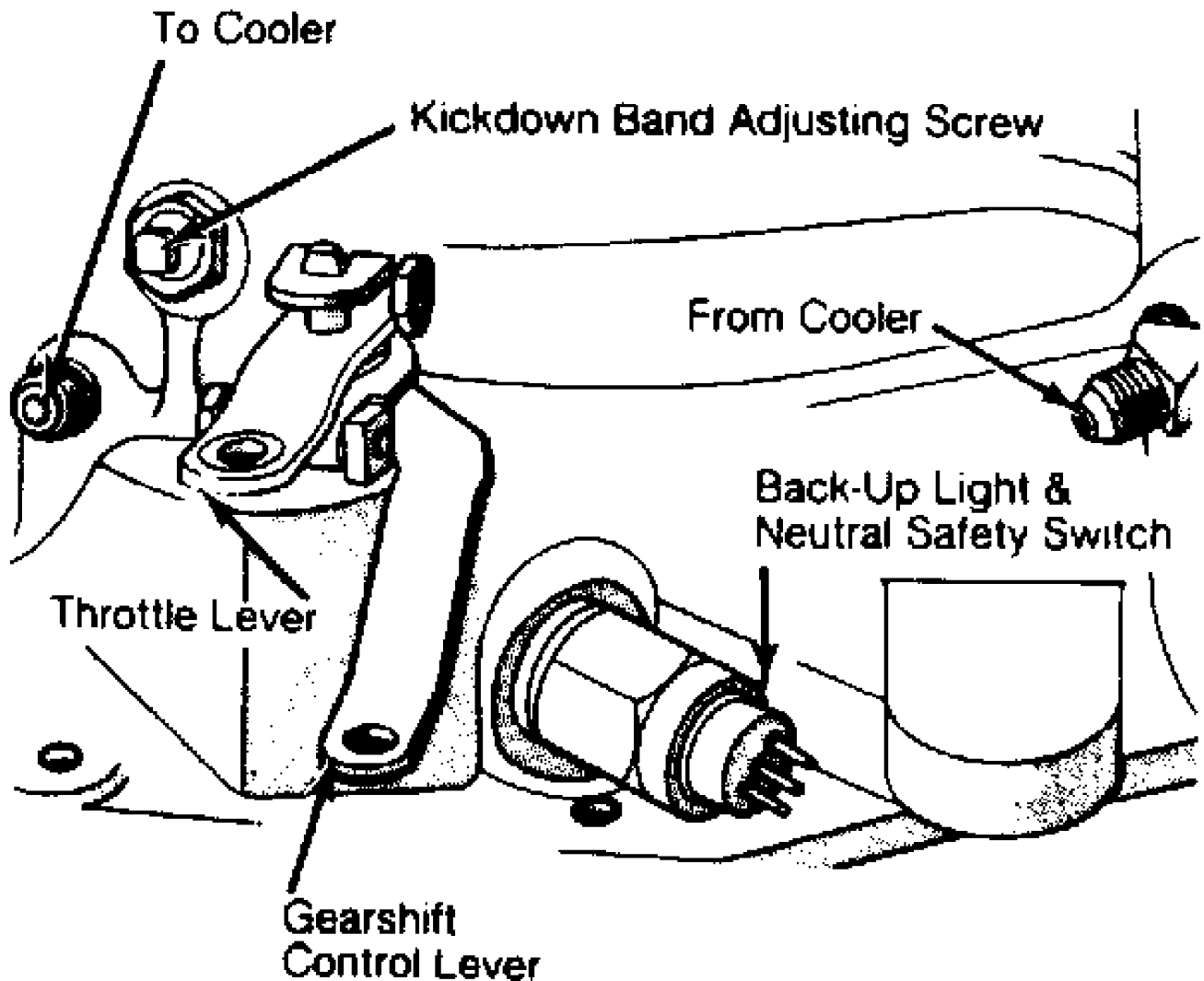


Fig. 1: Adjusting Kickdown (Front) Band  
Courtesy of Chrysler Corp.

#### LOW-REVERSE (REAR) BAND (TYPICAL)

32RH

1) Raise and support vehicle. Drain transmission fluid and remove oil pan. Locate low-reverse band adjusting screw on rear servo lever. See Fig. 2. Loosen adjusting screw lock nut. Back off lock nut 5-6 turns.

2) Tighten adjusting screw to 72 INCH lbs. (8 N.m). Back off adjusting screw 4 turns. Hold adjusting screw and tighten lock nut to 25 ft. lbs. (34 N.m). Install oil pan and fill transmission with fluid.

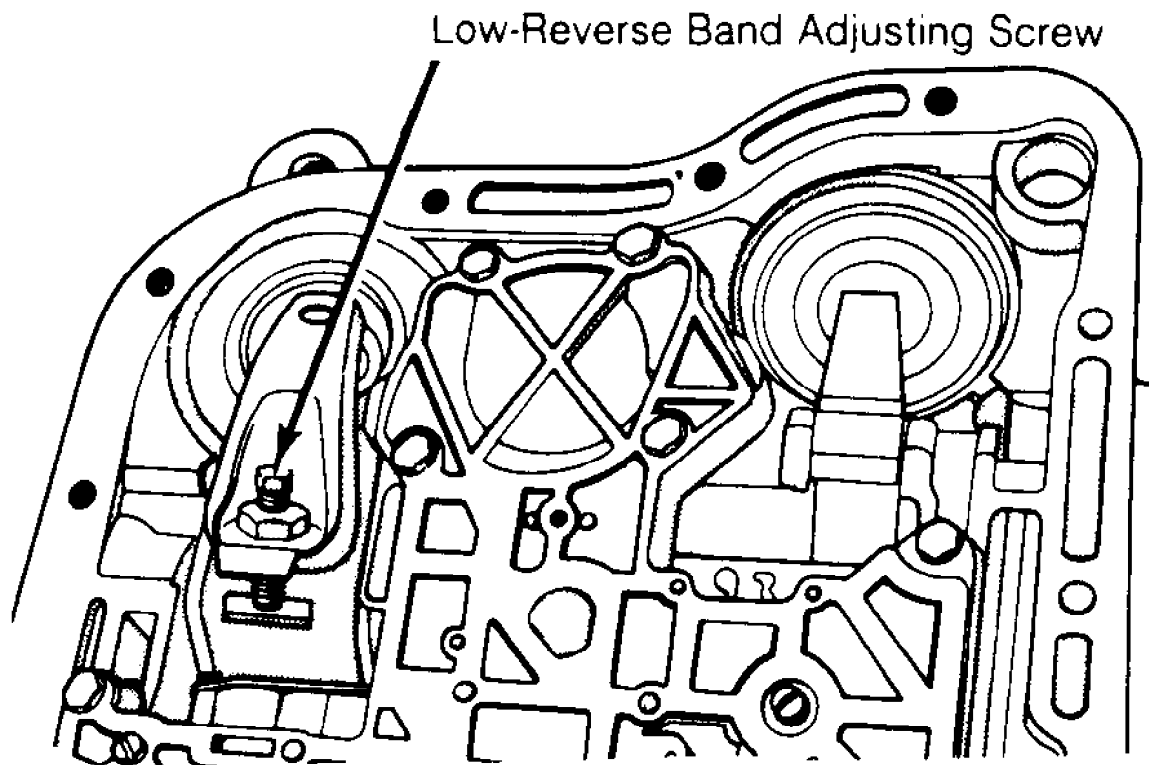


Fig. 2: Adjusting Low-Reverse (Rear) Band (Typical)  
Courtesy of Chrysler Corp.

## THROTTLE CABLE

With ignition off, fully retract cable plunger. Press cable button down and push cable plunger inward. Rotate throttle lever to wide open throttle position. Cable will ratchet to correct position. Release throttle lever. Cable is now adjusted.

## SHIFT LINKAGE

### AW-4

1) Place gearshift lever in Park and raise vehicle. Using a small screwdriver, unlock shift control cable by releasing "U" shaped cable adjuster clamp. Remove cable from mounting bracket.

2) Move transmission shift lever rearward until fully seated into Park detent. Ensure that drive shaft cannot be rotated. Snap control cable into cable mounting bracket and replace "U" shaped cable adjuster clamp. Lower vehicle and verify engine starting. Engine should start only with shifter in Park or Neutral.

### 32RH

1) Loosen shift rod trunnion jam nuts at transmission lever. Remove shift rod-to-bellcrank lock pin. Disengage trunnion and shift rod. Place selector lever in Park and lock steering column. Move transmission shift lever to full rear Park position.

2) Adjust shift rod trunnion to obtain free pin fit in bellcrank arm. Tighten jam nuts. On vehicles with shift lever on



column, ensure linkage lash is eliminated by pulling down on shift rod and pushing up on outer bellcrank when tightening jam nuts.

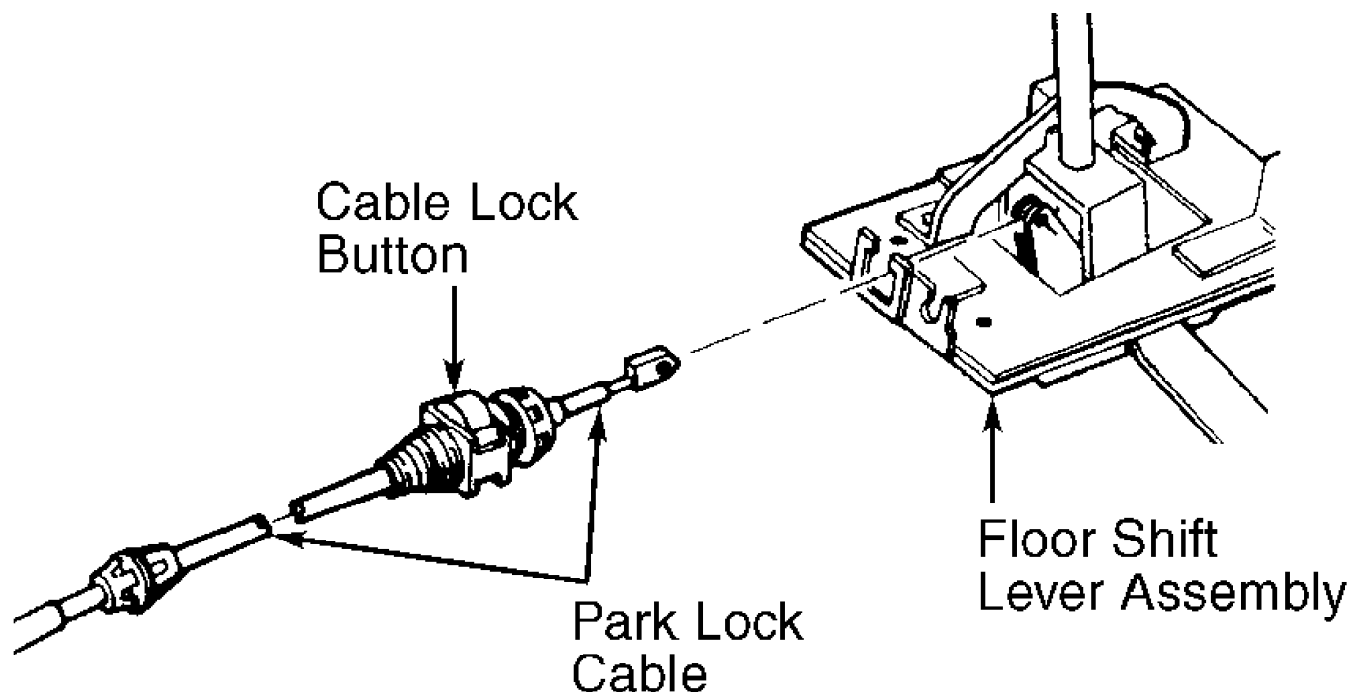
3) Check steering column lock for ease of operation. Ensure engine starts in Neutral or Park only. If starter engages in any drive gear, or does not work in Neutral or Park, check for proper shift linkage adjustment or faulty neutral safety switch.

## PARKING LOCK CABLE

AW-4

1) Shift transmission to Park. Turn ignition switch to lock position. Remove center console bezel to access cable adjustment.

2) Pull cable lock button up to release cable. See Fig. 3. Pull cable forward and release. Press lock button down until it snaps in place.



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Fig. 3: Adjusting Shift Cable  
Courtesy of Chrysler Corp.

3) Verify adjustment by trying to move shifter. Shifter button and/or shifter should not move.

4) Turn ignition on. Move shifter to Neutral. If ignition switch cannot be turned to Lock position, cable is adjusted. Repeat this step with shifter in Drive.

## NEUTRAL SAFETY SWITCH

AW-4

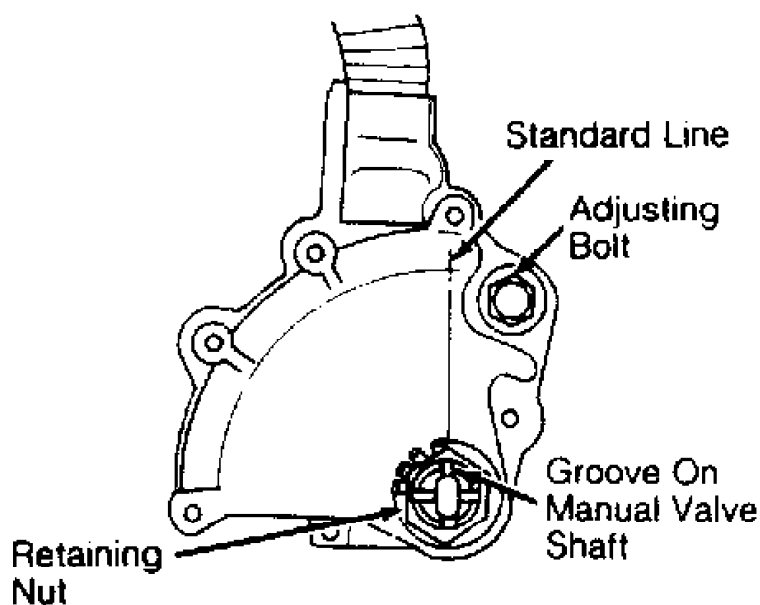
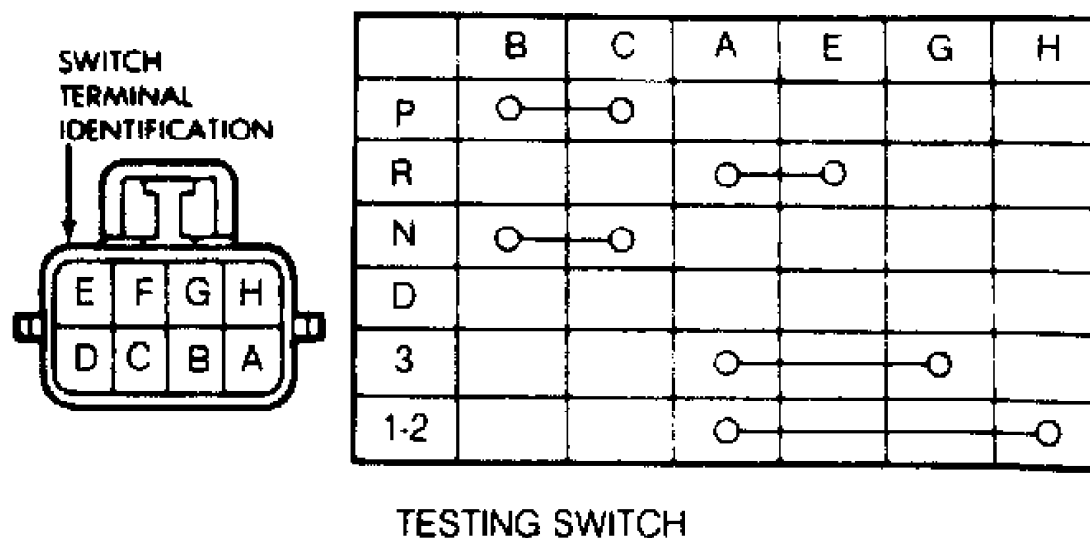
1) With transmission linkage properly adjusted, switch allows starter operation in Park or Neutral only.

2) To test switch, remove wire connector. Using ohmmeter, ensure continuity exists between proper terminals with transmission at specified gear range. See Fig. 4. Replace switch if faulty.

3) To replace switch, disconnect wire connector. Bend switch washer lock tabs upward and remove switch retaining nut and adjusting bolt. Remove switch assembly.

4) To install, disconnect shift linkage from transmission shift lever. Rotate shift lever all the way rearward and then forward 2 detent positions. This is the Neutral position. Install switch assembly.

5) Install adjusting bolt finger tight only. Install lock washer and retaining nut. Tighten nut to 61 INCH lbs. (7 N.m). Rotate switch to align standard line with groove of manual valve shaft. See Fig. 4. Tighten adjusting bolt to 108 INCH lbs. (13 N.m). Bend over lock tabs and install remaining components.



**ADJUSTING SWITCH**

Fig. 4: Testing & Adjusting Neutral Safety Switch  
Courtesy of Chrysler Corp.

32RH

1) With transmission linkage properly adjusted, switch should

allow starter operation in Park or Neutral only.

2) To test switch, remove wire harness and test for continuity between center pin of switch and transmission case. Continuity should only exist when transmission is in Park or Neutral.

3) Shift transmission into Reverse. Check for continuity between 2 outer switch terminals. Continuity should exist with transmission in Reverse only. With transmission in Reverse, check continuity between each outer switch terminal and transmission case. No continuity should exist between terminals and transmission case.

4) To replace switch, disconnect wire connector and unscrew switch from case. Move selector lever to Park and Neutral positions and ensure switch operating fingers are centered in switch opening.

5) Install switch and NEW seal in case. Tighten switch to 24 ft. lbs. (33 N.m). Check fluid level and add as needed.

## TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Kickdown (Front) Band Lock Nut .....	30 (41)
Low-Reverse (Rear) Band Lock Nut .....	25 (34)
Neutral Safety Switch (32RH) .....	25 (34)
Oil Pan Bolts .....	13 (18)
Transfer Case Fill Plug .....	20 (27)
	INCH Lbs. (N.m)
Filter	
AW-4 .....	84 (10)
32RH .....	35 (4)
Kickdown (Front) Band .....	(1) 72 (8)
Low-Reverse (Rear) Band .....	72 (8)
Neutral Safety Switch (AW-4)	
Retaining Nut .....	61 (7)
Adjusting Bolt .....	108 (13)

(1) - If adapter extension is used, tighten to 50 INCH lbs. (5 N.m). See text for complete adjusting procedure.

# TRANSMISSION SERVICING - M/T

1993 Jeep Cherokee

1993 MANUAL TRANSMISSION SERVICING  
Chrysler Corp.

Jeep: Cherokee, Grand Cherokee, Wrangler

## IDENTIFICATION

MANUAL TRANSMISSION APPLICATIONS TABLE

Model	Transmission
4-Cylinder	Aisin AX-5 5-Speed Overdrive
6-Cylinder	Aisin AX-15 5-Speed Overdrive

## LUBRICATION

### SERVICE INTERVALS

Transmission  
Check fluid level at 7500 mile intervals. Change fluid at 30,000 miles or at 30 month intervals.

Transfer Case  
Check transfer case fluid every 7500 miles and replace fluid every 30,000 miles or at 30 month intervals.

### CHECKING FLUID LEVEL

Transmission  
Remove fill plug. Check oil level. If level is not up to bottom of fill plug opening, add lubricant.

Transfer Case  
Remove fill plug. Check oil level. If level is not up to bottom of fill plug opening, add lubricant.

### RECOMMENDED FLUID

Use Mercon type ATF in transfer cases. Use SAE 75W-90 gear lube with API rating of GL-5 in transmissions.

## FLUID CAPACITIES

TRANSMISSION REFILL CAPACITIES TABLE

Application	Pts. (L)
AX-5 (2WD 5-Speed)	7.4 (3.5)
AX-5 (4WD 5-Speed)	7.0 (3.3)
AX-15 (5-Speed)	6.7 (3.2)

TRANSFER CASE REFILL CAPACITIES TABLE

Application	Pts. (L)
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Model 231

Cherokee	.....	2.2	(1.0)
Wrangler	.....	3.3	(1.5)
Model 242	.....	3.0	(1.4)
Model 249	.....	3.0	(1.4)

DRAINING & REFILLING

Transmission

Position drain pan under transmission. Remove drain plug from transmission. Remove fill plug for easier draining. With fluid fully drained, reinstall drain plug. Fill transmission and install fill plug.

Transfer Case

Position drain pan under transfer case. Remove drain plug from transfer case. Remove fill plug for easier draining. With fluid fully drained, reinstall drain plug. Fill transfer case and install fill plug. Tighten drain plug and fill plugs to 20 ft. lbs. (27 N.m).

ADJUSTMENTS

SHIFT LINKAGE

NOTE: Transmissions require no external shift linkage adjustments.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Drain Plug .....	27 (37)
Fill Plug .....	27 (37)

# TRANSMISSION OIL PAN GASKET ID - A/T

1993 Jeep Cherokee

1993 TRANSMISSION SERVICING  
Chrysler Corp. Oil Pan Gasket Identification  
Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## IDENTIFICATION

### JEEP AUTOMATIC TRANSMISSION APPLICATIONS TABLE

Model	Transmission
Except Wrangler .....	Aisin Warner AW-4
Wrangler .....	Chrysler 32RH (Formerly A-999)

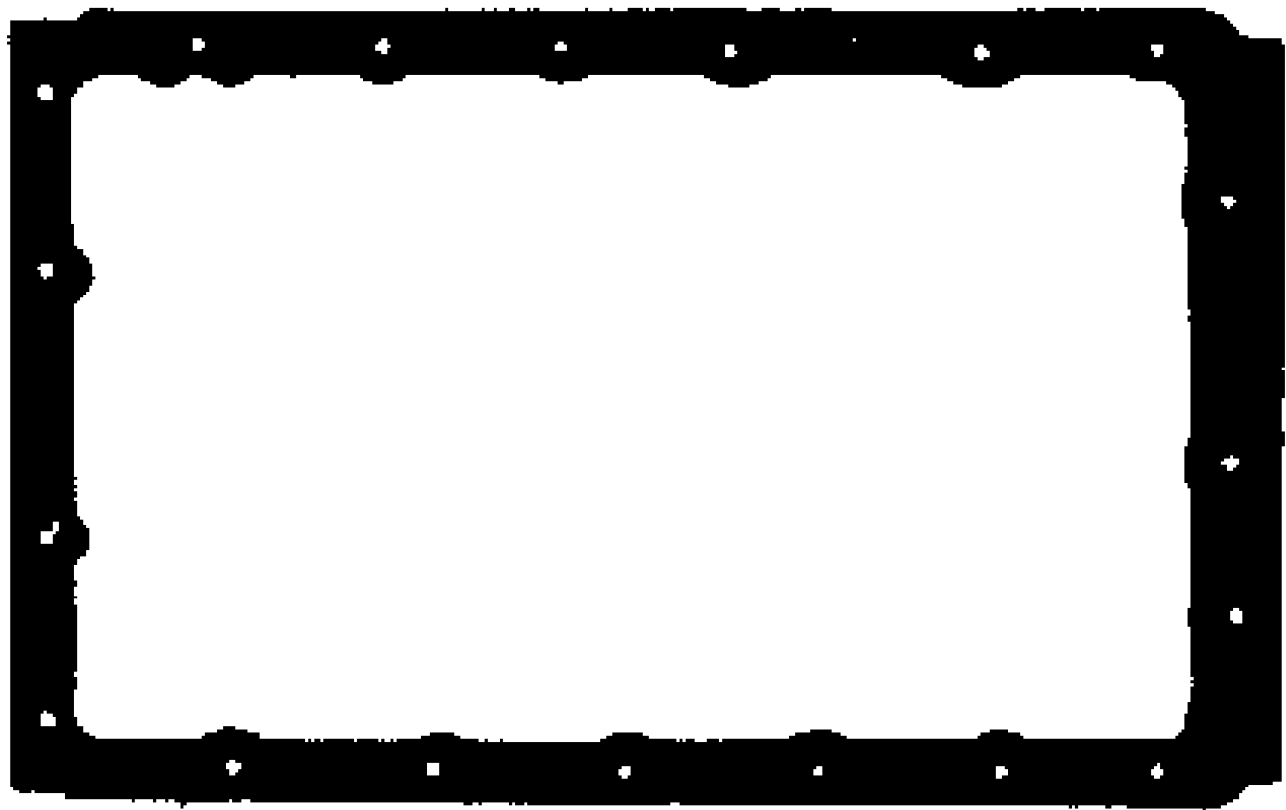


Fig. 1: AW-4 Oil Pan Gasket Identification

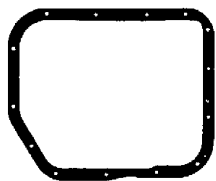


Fig. 2: 32RH Oil Pan Gasket Identification

# TROUBLE SHOOTING - BASIC PROCEDURES

1993 Jeep Cherokee

## GENERAL TROUBLE SHOOTING

### \* PLEASE READ THIS FIRST \*

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

## ACCESSORIES & ELECTRICAL

### CHARGING SYSTEM TROUBLE SHOOTING

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#### BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Vehicle Will Not Start	Dead battery	Check battery cells, alternator belt tension and alternator output
	Loose or corroded battery connections	Check all charging system connections
	Ignition circuit or switch malfunction	Check and replace as necessary
Alternator Light Stays On With Engine Running	Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
	Loose alternator wiring connections	Check all charging system connections
	Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
	Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
	Defective regulator	See Regulator Check in

		ALTERNATOR article
Alternator Light Stays Off With Ignition Switch ON	Blown fuse	See WIRING DIAGRAMS
	Defective alternator	See Testing in ALTERNATOR article
	Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Alternator Light Stays OFF With Ignition Switch ON	Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
	Defective rectifier bridge	See Bench Tests in ALTERNATOR article
Lights or Fuses Burn Out Frequently	Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
	Defective regulator	See Regulator Check in ALTERNATOR article
	Defective battery	Check and replace as necessary
Ammeter Gauge Shows Discharge	Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section
	Defective wiring	Check all wires and wire connections
	Defective alternator or regulator	See Bench Tests and On-Vehicle Tests in ALTERNATOR article
	Defective ammeter, or improper ammeter wiring connection	See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Noisy Alternator	Loose drive pulley	Tighten drive pulley attaching nut
	Loose mounting bolts	Tighten all alternator mounting bolts
	Worn or dirty bearings	See Bearing Replacement ALTERNATOR article

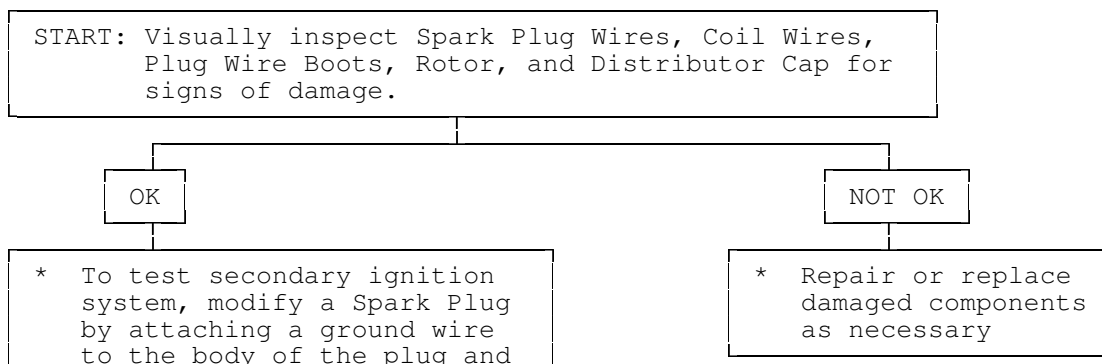


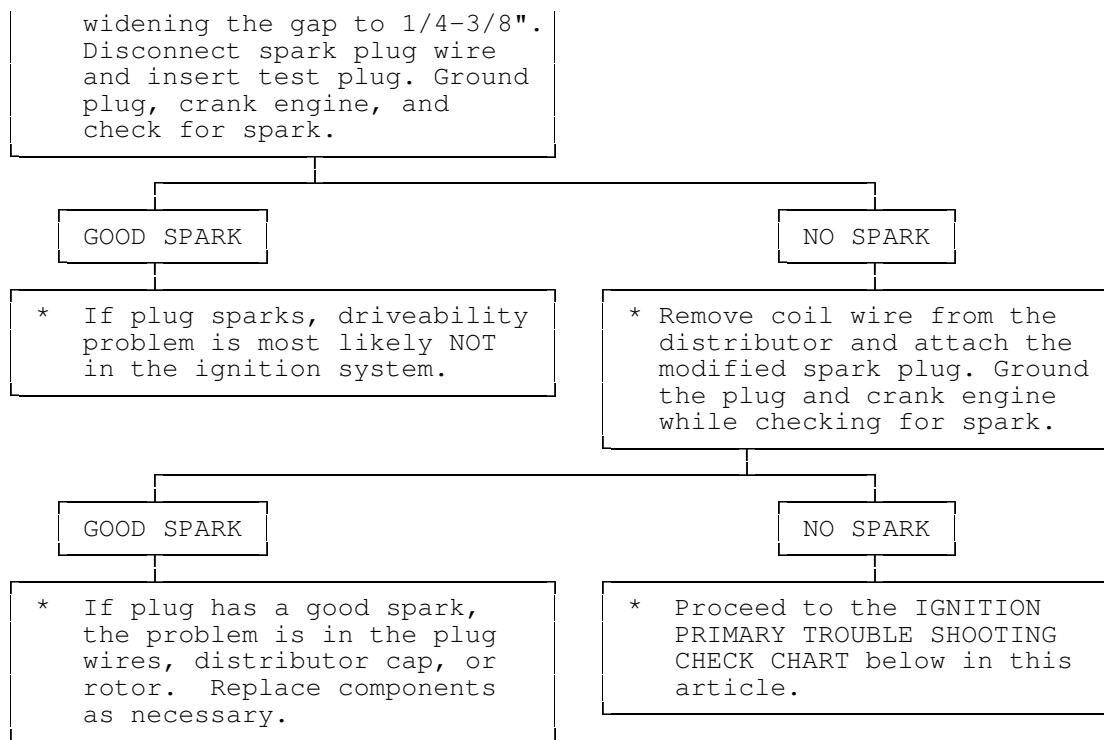
	Defective diodes or stator	See Bench Test in ALTERNATOR article
Battery Does Stay Charged	Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section
	Loose or corroded battery connections	Check all charging system connections
	Loose alternator connections	Check all charging system connections
	Defective alternator or battery	See On-Vehicle Tests and Bench Tests in ALTERNATOR article
	Add-on electrical accessories exceeding alternator capacity	Install larger alternator
Battery Overcharged- Uses Too Much Water	Defective battery	Check alternator output and repair as necessary
	Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
	Excessive alternator voltage	Check alternator output and repair as necessary

## IGNITION SYSTEM TROUBLE SHOOTING

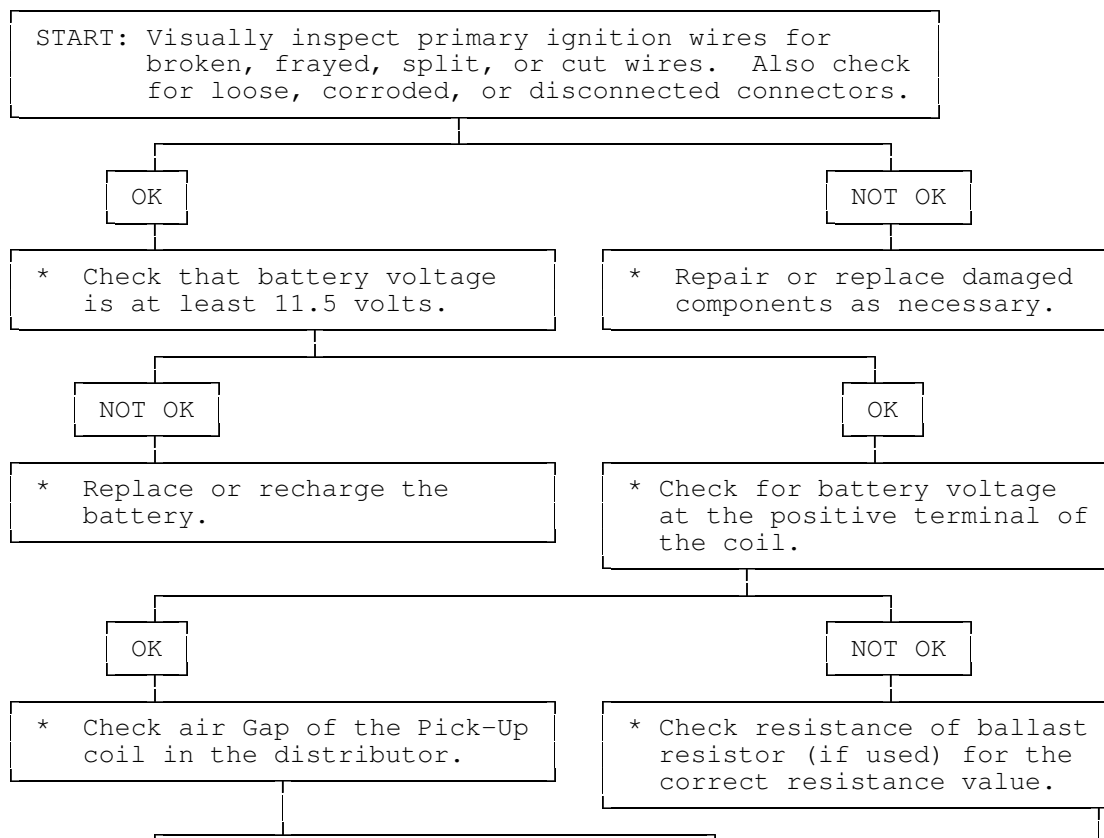
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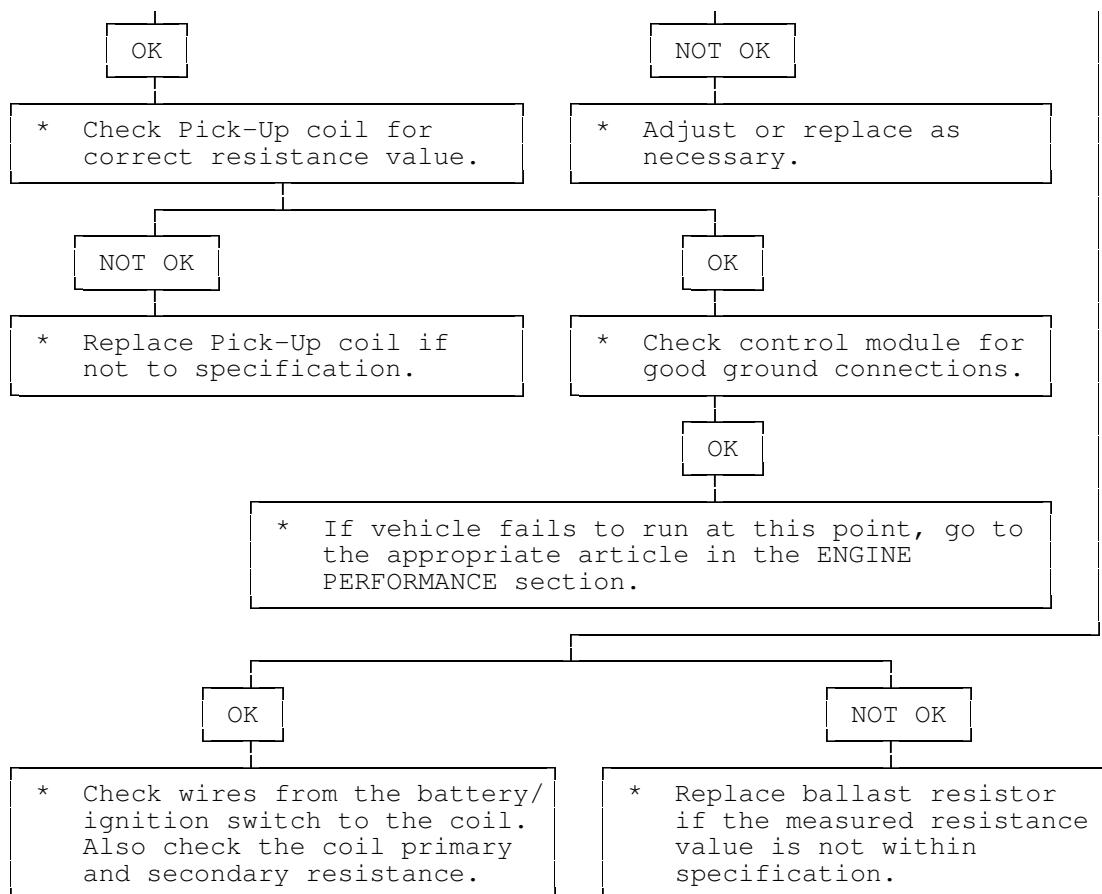
Ignition Secondary Trouble Shooting Chart





### Ignition Primary Trouble Shooting Chart





## STARTER TROUBLE SHOOTING

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### BASIC STARTER TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
	Ignition switch faulty or misadjusted	Adjust or replace ignition switch
	Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
	Starter relay or starter defective	See Testing in STARTER article

	Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	Weak battery or dead cell	Charge or replace battery as necessary
	Loose or corroded battery connections	Check that battery connections are clean and tight
	Internal ground in starter windings	See Testing in STARTER article
	Grounded starter fields	See Testing in STARTERS
	Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	Starter clutch slipping	See STARTER article
	Broken clutch housing	See STARTER article
	Pinion shaft rusted or dry	See STARTER article
	Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
	Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	Faulty overrunning clutch	See STARTER article
	Broken clutch housing	See STARTER article
	Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
	Armature shaft sheared or reduction gear teeth stripped	See STARTER article
	Weak battery	Charge or replace battery as necessary
	Faulty solenoid	See On-Vehicle Tests in STARTER article
	Poor grounds	Check all ground connections for tight and clean connections
	Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	Battery weak or defective	Charge or replace battery as necessary

	Engine overheated	See ENGINE COOLING SYSTEM article
	Engine oil too heavy	Check that proper viscosity oil is used
	Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
	Current draw too low or too high	See Bench Tests in STARTER article
	Bent armature, loose pole shoes screws or worn bearings	See STARTER article
	Burned solenoid contacts	Replace solenoid
	Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	Engine timing too far advanced	See Ignition Timing in TUNE-UP article
	Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
	Broken starter clutch	See STARTER article
	Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
	Weak drive assembly thrust spring	See STARTER article
	Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	Defective point assembly	See Testing in STARTER article
	Poor point assembly ground	See Testing in STARTER article
	Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	Dead battery	Charge or replace battery as necessary
	Faulty wiring	Check all wiring and connections leading to relay
	Neutral safety switch faulty	Replace neutral safety switch
	Starter relay faulty	Replace starter relay

Starter Drive Will Not Disengage	Starter motor loose on mountings	Tighten starter attach bolts
	Worn drive end bushing	See STARTER article
	Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
	Drive yolk return spring broken or missing	Replace return spring
	Faulty ignition switch	Replace ignition switch
	Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
	Starter clutch not disengaging	Replace starter clutch
	Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	Faulty solenoid switch, switch connections or	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
	Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	Weak battery	Charge or replace battery as necessary
	Solenoid contacts corroded	Clean contacts or replace solenoid
	Faulty wiring	Check all wiring leading to solenoid
	Broken connections inside switch cover	Repair connections or replace solenoid
	Open hold-in wire	Replace solenoid
Low Current Draw	Worn brushes or weak	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine	Distance too small between starter pinion and flywheel	

Fires With Key            Flywheel runout contributes  
released. Engine        to the intermittent nature  
Fires and Cranks  
Normally

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**AIR CONDITIONING & HEAT**

**AIR CONDITIONING TROUBLE SHOOTING**

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Compressor Not Working	<ul style="list-style-type: none"><li>• Compressor clutch circuit open.</li><li>• Compressor clutch coil inoperative.</li><li>• Poor clutch ground connection.</li><li>• Fan belts loose.</li><li>• Thermostatic switch inoperative.</li><li>• Thermostatic switch not adjusted.</li><li>• Ambient temperature switch open.</li><li>• Superheat fuse blown.</li></ul>
Excessive Noise or Vibration	<ul style="list-style-type: none"><li>• Missing or loose mounting bolts.</li><li>• Bad idler pulley bearings.</li><li>• Fan belts not tightened correctly.</li><li>• Compressor clutch contacting body.</li><li>• Excessive system pressure.</li><li>• Compressor oil level low.</li><li>• Damaged clutch bearings.</li><li>• Damaged reed valves.</li><li>• Damaged compressor.</li></ul>
Insufficient or No Cooling; Compressor Working	<ul style="list-style-type: none"><li>• Expansion valve inoperative.</li><li>• Heater control valve stuck open.</li><li>• Low system pressure.</li><li>• Blocked condenser fins.</li><li>• Blocked evaporator fins.</li><li>• Vacuum system leak.</li><li>• Vacuum motors inoperative.</li><li>• Control cables improperly adjusted.</li><li>• Restricted air inlet.</li><li>• Mode doors binding.</li><li>• Blower motor inoperative.</li><li>• Temperature above system capacity.</li></ul>

**HEATER SYSTEM TROUBLE SHOOTING**

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problem symptoms. For model-specific Trouble Shooting, refer to DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

#### BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Insufficient, Erratic, or No Heat	<ul style="list-style-type: none"><li>• Low Coolant Level</li><li>• Incorrect thermostat.</li><li>• Restricted coolant flow through heater core.</li><li>• Heater hoses plugged.</li><li>• Misadjusted control cable.</li><li>• Sticking heater control valve.</li><li>• Vacuum hose leaking.</li><li>• Vacuum hose blocked.</li><li>• Vacuum motors inoperative.</li><li>• Blocked air inlet.</li><li>• Inoperative heater blower motor.</li><li>• Oil residue on heater core fins.</li><li>• Dirt on heater core fins.</li></ul>
Too Much Heat	<ul style="list-style-type: none"><li>• Improperly adjusted cables.</li><li>• Sticking heater control valve.</li><li>• No vacuum to heater control valve.</li><li>• Temperature door stuck open.</li></ul>
Air Flow Changes During Acceleration	<ul style="list-style-type: none"><li>• Vacuum system leak.</li><li>• Bad check valve or reservoir.</li></ul>
Air From Defroster At All Times	<ul style="list-style-type: none"><li>• Vacuum system leak.</li><li>• Improperly adjusted control cables.</li><li>• Inoperative vacuum motor.</li></ul>
Blower Does Not Operate Correctly	<ul style="list-style-type: none"><li>• Blown fuse.</li><li>• Blower motor windings open.</li><li>• Resistors burned out.</li><li>• Motor ground connection loose.</li><li>• Wiring harness connections loose.</li><li>• Blower motor switch inoperative.</li><li>• Blower relay inoperative.</li><li>• Fan binding or foreign object in housing.</li><li>• Fan blades broken or bent.</li></ul>

## BRAKES

### BRAKE SYSTEM TROUBLE SHOOTING

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## BRAKE SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Brakes Pull Left or Right	Incorrect tire pressure	Inflate tires to proper pressure
	Front end out of alignment	See WHEEL ALIGNMENT
	Mismatched tires	Check tires sizes
	Restricted brake lines or hoses	Check hose routing
	Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
	Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
	Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
	Loose suspension parts	See SUSPENSION
Noises Without Brakes Applied	Front linings worn out	Replace linings
	Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
Noises With Brakes Applied	Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
	Incorrect pads or linings	Replace pads or linings
Brake Rough, Chatters or Pulsates	Excessive lateral runout	Check rotor runout
	Parallelism not to specifications	Reface or replace rotor
	Wheel bearings not adjusted	See SUSPENSION
	Rear drums out-of-round	Reface or replace drums
	Disc pad reversed, steel against rotor	Remove and reinstall pad
Excessive Pedal Effort	Malfunctioning power unit	See POWER BRAKES or BRAKE SYSTEM
	Partial system failure	Check fluid and pipes
	Worn disc pad or lining	Replace pad or lining
	Caliper piston stuck or	

	sluggish	See DISC BRAKES or BRAKE SYSTEM
	Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
	Brake fade due to incorrect pads for linings	Replace pads or linings
	Linings or pads glazed	Replace pads or linings
	Worn drums	Reface or replace drums
<hr/>		
Excessive Pedal Travel	Partial brake system failure	Check fluid and pipes
	Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
	Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
	Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
	Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
	Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
	Improper brake fluid	Replace brake fluid
<hr/>		
Pedal Travel Decreasing	Compensating port plugged	See MASTER CYLINDERS or BRAKE SYSTEM
	Swollen cup in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
	Master cylinder piston not returning	See MASTER CYLINDERS or BRAKE SYSTEM
	Weak shoe retracting springs	See DRUM BRAKES or BRAKE SYSTEM
	Wheel cylinder piston sticking	See DRUM BRAKES or BRAKE SYSTEM
<hr/>		
Dragging Brakes	Master cylinder pistons not returning	See MASTER CYLINDERS or BRAKE SYSTEM
	Restricted brake lines or hoses Incorrect parking brake adjustment	Check line routing  See DRUM BRAKES or BRAKE SYSTEM

	Parking Brake cables frozen	See DRUM BRAKES BRAKE SYSTEM
	Incorrect installation of inboard disc pad	Remove and replace correctly
	Power booster output rod too long	See POWER BRAKE UNITS BRAKE SYSTEM
	Brake pedal not returning freely	See DISC, DRUM BRAKES BRAKE SYSTEM
Brakes Grab or Uneven Braking Action	Malfunction of combination valve	See CONTROL VALVE or BRAKE SYSTEM
	Malfunction of power brake unit	See POWER BRAKE UNITS or BRAKE SYSTEM
	Binding brake pedal	See DISC, DRUM BRAKES or BRAKE SYSTEM
Pulsation or Roughness	Uneven pad wear caused by caliper	See DISC BRAKES or BRAKE SYSTEM
	Uneven rotor wear	See DISC BRAKES or BRAKE SYSTEM
	Drums out-of-round	Reface or replace drums

## ENGINE MECHANICAL

### COOLING SYSTEM TROUBLE SHOOTING

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#### COOLING SYSTEM TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	CORRECTION
Overheating	Coolant Leak	Fill/Pressure Test System
	A/C Condenser Fins Clogged	Remove/Clean Condenser
	Radiator Fins Clogged	Remove/Clean Radiator
	Thermostat Stuck Closed	Replace Thermostat
	Clogged Cooling System Passages	Clean/Flush Cooling System

	Water Pump Malfunction	Replace Water Pump
	Fan Clutch Malfunction	Replace Fan Clutch
	Retarded Ignition Timing	Reset Ignition Timing
	Cooling Fan Malfunction	Test Cooling Fan/ Circuit
	Cooling Fan Motor Malfunction	Test Fan Motor
	Cooling Fan Relay Malfunction	Test Fan Relay
	Faulty Radiator Cap	Replace Radiator Cap
	Broken/Slipping Fan Belt	Replace Fan Belt
	Restricted Exhaust	Repair Exhaust System
Corrosion	Impurities In Coolant	Clean/Flush System
Coolant Leakage	Damaged hose	Replace Hose
	Leaky Water Pump	Replace Water Pump
	Damaged Radiator Seam	Replace/Repair Radiator
	Leaky Thermostat Cover	Replace Thermostat Cover
	Cylinder Head Problem	Check Head/Head Gasket
	Leaky Freeze Plugs	Replace Freeze Plugs
Recovery System Inoperative	Loose and/or Defective Radiator Cap	Replace Radiator Cap
	Overflow Tube Clogged and/or Leaking	Repair Tube
	Recovery Bottle Vent Restricted	Clean Vent
No Heater Core Flow	Collapsed Heater Hose	Replace Heater Hose
	Plugged Heater Core	Clean/Replace Heater Core
	Faulty Heater Valve	Replace Heater Valve

## GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

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in the section(s) you are accessing.

# BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Lopes At Idle	Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
	Blown head gasket	Replace head gasket, See ENGINES
	Worn timing gears, chain or sprocket	Replace gears, chain or sprocket
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Overheated engine	Check cooling system, See COOLING
	Blocked crankcase vent valve	Remove restriction
	Leaking EGR valve	Repair leak and/or replace valve
	Faulty fuel pump	Replace fuel pump
Engine Has Low Power	Leaking fuel pump	Repair leak and/or replace fuel pump
	Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
	Sticking valves or weak valve springs	Check valve train components, See ENGINES
	Incorrect valve timing	Reset valve timing, See ENGINES
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Blown head gasket	Replace head gasket. See ENGINES.
	Clutch slipping	Adjust pedal and/or replace components, See ENGINES
	Engine overheating	Check cooling system, See COOLING
	Auto. Trans. pressure regulator valve faulty	Replace pressure regulator valve
	Auto. Trans. fluid level too low	Add fluid as necessary
	Improper vacuum diverter valve operation	Replace vacuum diverter valve
	Vacuum leaks	Inspect vacuum system and repair as required
	Leaking piston rings	Replace piston rings, See ENGINES
Faulty High Speed Operation	Low fuel pump volume	Replace fuel pump
	Leaking valves or worn	Replace valves and/or springs, See ENGINES
	Incorrect valve timing	Reset valve timing, See ENGINES
	Intake manifold restricted	Remove restriction
	Worn distributor shaft	Replace distributor
Faulty Acceleration	Improper fuel pump stroke	Remove pump and reset pump stroke

	Incorrect ignition timing	Reset ignition timing, See TUNE-UP
	Leaking valves	Replace valves, See ENGINES
	Worn fuel pump diaphragm or piston	Replace diaphragm or piston
Intake Backfire	Improper ignition timing	Reset ignition timing, See TUNE-UP
	Faulty accelerator pump discharge	Replace accelerator pump
	Improper choke operation	Check choke and adjust as required
	Defective EGR valve	Replace EGR valve
	Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
	Choke valve initial clearance too large	Reset choke valve initial clearance
Exhaust Backfire	Vacuum leak	Inspect and repair vacuum system
	Faulty vacuum diverter valve	Replace vacuum diverter valve
	Faulty choke operation	Check choke and adjust as required
	Exhaust system leak	repair exhaust system leak
Engine Detonation	Ignition timing too far advanced	Reset ignition timing, See TUNE-UP
	Faulty ignition system	Check ignition timing, See TUNE-UP
	Spark plugs loose or faulty	Retighten or replace plugs
	Fuel delivery system clogged	Inspect lines, pump and filter for clog
	EGR valve inoperative	Replace EGR valve
	PCV system inoperative	Inspect and/or replace hoses or valve
	Vacuum leaks	Check vacuum system and repair leaks
	Excessive combustion chamber deposits	Remove built-up deposits
	Leaking, sticking or broken valves	Inspect and/or replace valves
External Oil Leakage	Fuel pump improperly seated or worn gasket	Remove pump, replace gasket and seat properly
	Oil pan gasket broken or pan bent	Straighten pan and replace gasket
	Timing chain cover gasket broken	Replace timing chain cover gasket
	Rear main oil seal worn	Replace rear main oil seal
	Oil pan drain plug not seated properly	Remove and reinstall drain plug
	Camshaft bearing drain hole blocked	Remove restriction
	Oil pressure sending switch leaking	Remove and reinstall sending switch

Excessive Oil Consumption	Worn valve stems or guides	Replace stems or guides, See ENGINES
	Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
	Plugged oil drain back holes	Remove restrictions
	Improper PCV valve operation	Replace PCV valve
	Engine oil level too high	Remove excess oil
	Engine oil too thin	Replace thicker oil
	Valve stem oil deflectors damaged	Replace oil deflectors
	Incorrect piston rings	Replace piston rings, See ENGINES
	Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
	Insufficient piston ring tension	Replace rings, See ENGINES
	Piston ring grooves or oil return slots clogged	Replace piston rings, See ENGINES
	Piston rings sticking in grooves	Replace piston rings, See ENGINES
	Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
	Compression rings installed upside down	Replace compression rings correctly, See ENGINES
	Worn or scored cylinder walls	Rebore cylinders or replace block
	Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
	Intake gasket dowels too long	Replace intake gasket dowels
	Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES
No Oil Pressure	Low oil level	Add oil to proper level
	Oil pressure sender or gauge broken	Replace sender or gauge
	Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
	Oil pressure relief valve sticking	Remove and reinstall valve
	Oil pump passages blocked	Overhaul oil pump, See ENGINES
	Oil pickup screen or tube blocked	remove restriction
	Loose oil inlet tube	Tighten oil inlet tube
	Loose camshaft bearings	Replace camshaft bearings, See ENGINES
	Internal leakage at oil passages	Replace block or cylinder head
Low Oil Pressure	Low engine oil level	Add oil to proper level
	Engine oil too thin	Remove and replace with thicker oil
	Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
	Oil pickup tube or screen blocked	Remove restrictions
	Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See

## ENGINES

High Oil Pressure	Improper grade of oil Oil pressure relief valve stuck closed Oil pressure sender or gauge faulty	Replace with proper oil Eliminate binding Replace sender or gauge
Noisy Main Bearings	Inadequate oil supply Excessive main bearing clearance Excessive crankshaft end play Loose flywheel or torque converter Loose or damaged vibration damper Crankshaft journals out-of-round Excessive belt tension	Check oil delivery to main bearings Replace main bearings, See ENGINES Replace crankshaft, See ENGINES Tighten attaching bolts Tighten or replace vibration damper Re-grind crankshaft journals Loosen belt tension
Noisy Connecting Rods	Excessive bearing clearance or missing bearing Crankshaft rod journal out-of-round Misaligned connecting rod or cap Incorrectly tightened rod bolts	Replace bearing, See ENGINES Re-grind crankshaft journal Remove rod or cap and realign Remove and re-tighten rod bolts
Noisy Pistons and Rings	Excessive piston-to-bore clearance Bore tapered or out-of-round Piston ring broken Piston pin loose or seized Connecting rods misaligned Ring side clearance too loose or tight Carbon build-up on piston	Install larger pistons, See ENGINES Rebore block Replace piston rings, See ENGINES Replace piston pin, See ENGINES Realign connecting rods Replace with larger or smaller rings Remove carbon
Noisy Valve Train	Worn or bent push rods Worn rocker arms or bridged pivots Dirt or chips in valve lifters Excessive valve lifter leak-down Valve lifter face worn Broken or cocked valve springs Too much valve stem-to-guide clearance Valve bent Loose rocker arms Excessive valve seat run-out	Replace push rods, See ENGINES Replace push rods, See ENGINES Remove lifters and remove dirt/chips Replace valve lifters, See ENGINES Replace valve lifters, See ENGINES replace or reposition springs Replace valve guides, See ENGINES Replace valve, See ENGINES Retighten rocker arms, See ENGINES Reface valve seats, See ENGINES



	Missing valve lock	Install new valve lock
	Excessively worn camshaft lobes	Replace camshaft, See ENGINES
	Plugged valve lifter oil holes	Eliminate restriction or replace lifter
	Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
	Rocker arm nut installed upside down	Remove and reinstall correctly
	Valve lifter incorrect for engine	Remove and replace valve lifters
	Faulty push rod seat or lifter plunger	Replace plunger or push rod
Noisy Valves	Improper valve lash	Re-adjust valve lash, See ENGINES
	Worn or dirty valve lifters	Clean and/or replace lifters
	Worn valve guides	Replace valve guides, See ENGINES
	Excessive valve seat or face run-out	Reface seats or valve face
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
	Bent push rods	Replace push rods, See ENGINES
	Broken valve springs	Replace valve springs, See ENGINES
Burned, Sticking or Broken Valves	Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
	Improper lifter clearance	Re-adjust clearance or replace lifters
	Worn guides or improper guide clearance	Replace valve guides, See ENGINES
	Out-of-round valve seats or improper seat width	Re-grind valve seats
	Gum deposits on valve stems, seats or guides	Remove deposits
	Improper spark timing	Re-adjust spark timing
Broken Pistons/Rings	Undersize pistons	Replace with larger pistons, See ENGINES
	Wrong piston rings	Replace with correct rings, See ENGINES
	Out-of-round cylinder bore	Re-bore cylinder bore
	Improper connecting rod alignment	Remove and realign connecting rods
	Excessively worn ring grooves	Replace pistons, See ENGINES
	Improperly assembled piston pins	Re-assemble pin-to-piston, See ENGINES
	Insufficient ring gap clearance	Install new rings, See ENGINES
	Engine overheating	Check cooling system
	Incorrect ignition timing	Re-adjust ignition timing, See TUNE-UP
Excessive Exhaust Noise	Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
	Exhaust manifold	Replace exhaust

cracked or broken

manifold, See ENGINES

## ENGINE PERFORMANCE

### CARBURETOR TROUBLE SHOOTING:

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#### BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start	Choke not closing	Check choke operation, see FUEL SYSTEMS
	Choke linkage bent	Check linkage, see FUEL SYSTEM
Engine Starts, Then Dies	Choke vacuum kick setting too wide	Check setting and adjust see, FUEL SYSTEMS
	Fast idle RPM too low	Reset RPM to specification, see TUNE-UP
	Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
	Vacuum leak	Inspect vacuum system for leaks
	Low fuel pump outlet	Repair or replace pump, see FUEL SYSTEMS
	Low carburetor fuel level	Check float setting see FUEL SYSTEM
Engine Quits Under Load	Choke vacuum kick setting incorrect	Reset vacuum kick setting, see FUEL SYSTEMS
	Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEM
	Incorrect hot fast idle speed RPM	Reset fast idle RPM, see TUNE-UP
Engine Starts, Runs Up, Then Idles, Slowly With Black Smoke	Choke vacuum kick set too narrow	Reset vacuum kick, see FUEL SYSTEMS
	Fast idle cam index	Reset fast idle cam

incorrect

index, see FUEL  
SYSTEMS

Hot fast idle RPM too low

Reset fast idle RPM,  
see TUNE-UP

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#### BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

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CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start	Engine flooded	Allow fuel to evaporate

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#### BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

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CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Stalls in Gear	Choke vacuum kick setting incorrect	Reset choke vacuum kick, see FUEL SYSTEMS
	Fast idle RPM incorrect	Reset fast idle RPM, see TUNE-UP
	Fast idle cam index incorrect	Reset fast idle cam see FUEL SYSTEMS
Acceleration Sag or Stall	Defective choke control switch	Replace choke control switch
	Choke vacuum kick setting incorrect	Reset choke vacuum kick see, FUEL SYSTEMS
	Float level incorrect (too low)	Adjust float level, FUEL SYSTEMS
	Accelerator pump defective	Repair or replace pump see FUEL SYSTEMS
	Secondary throttles not closed	Inspect lockout adjustment, see FUEL SYSTEMS
Sag or Stall After Warmup	Defective choke control switch	Replace choke control switch, see FUEL SYSTEMS
	Defective accelerator pump	Replace pump, see FUEL SYSTEMS
	Float level incorrect (too low)	Adjust float level, see FUEL SYSTEMS
Backfiring & Black Smoke	Plugged heat crossover system	Remove restriction

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#### BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

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CONDITION	POSSIBLE CAUSE	CORRECTION
Hesitation With Small Amount of Gas Pedal Movement	Vacuum leak	Inspect vacuum lines
	Accelerator pump weak or inoperable	Replace pump, see FUEL SYSTEMS
	Float level setting too low	Reset float level, see, FUEL SYSTEMS
	Metering rods sticking or binding	Inspect and/or replace rods, see FUEL SYSTEMS
	Carburetor idle or transfer system plugged	Inspect system and remove restriction
	Frozen or binding heated air inlet	Inspect heated air door for binding
Hesitation With Heavy Gas Pedal Movement	Defective accelerator pump	Replace pump, see FUEL SYSTEMS
	Metering rod carrier sticking or binding	Remove restriction
	Large vacuum leak	Inspect vacuum system and repair leak
	Float level setting too low	Reset float level, see FUEL SYSTEMS
	Defective fuel pump, lines or filter	Inspect pump, lines and filter
	Air door setting incorrect	Adjust air door setting, see FUEL

## DIESEL ENGINE TROUBLE SHOOTING

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**NOTE:** Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

### BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Crank	Bad battery connections or dead batteries	Check connections and/or replace

	Bad starter connections or bad starter	batteries Check connections and/or replace batteries
Engine Cranks Slowly, Won't Start	Bad battery connections or dead batteries	Check connections and/or replace batteries
	Engine oil too heavy	Replace engine oil
Engine Cranks Normally, But Will Not Start	Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
	Glow plug control not functioning	Check controller, see FUEL SYSTEMS
	Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
	No fuel to injection pump	Check fuel delivery system
	Fuel filter blocked	Replace fuel filter
	Fuel tank filter blocked	Replace fuel tank filter
	Fuel pump not operating	Check pump operation and/or replace pump
	Fuel return system blocked	Inspect system and remove restriction
	No voltage to fuel solenoid	Check solenoid and connections
	Incorrect or contaminated fuel	Replace fuel
	Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
	Low compression	Check valves, pistons, rings, see ENGINES
	Injection pump malfunction	Inspect and/or replace injection pump
Engine Starts, Won't Idle	Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
	Fast idle solenoid malfunctioning	Check solenoid and connections
	Fuel return system blocked	Check system and remove restrictions
	Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
	Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
	No fuel to injection pump	Check fuel delivery system
	Incorrect or contaminated fuel	Replace fuel
	Low compression	Check valves, piston, rings, see ENGINES
	Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
	Fuel solenoid closes in RUN position	Check solenoid and connections
Engines Starts/ Idles Rough W/out Smoke or Noise	Incorrect slow idle adjustment	Reset slow idle, see TUNE-UP
	Injection line fuel leaks	Check lines and connections
	Fuel return system blocked	Check lines and connections

	Air in fuel system Incorrect or contaminated fuel Injector nozzle malfunction	Bleed air from system Replace fuel Check nozzles, see FUEL SYSTEMS
Engines Starts and Idles Rough W/out Smoke or Noise, But Clears After Warm-Up	Injection pump timing incorrect Engine not fully broken in Air in system Injector nozzle malfunction	Reset pump timing, see FUEL SYSTEMS Put more miles on engine Bleed air from system Check nozzles, see FUEL SYSTEMS
Engine Idles Correctly, Misfires Above Idle	Blocked fuel filter Injection pump timing incorrect Incorrect or contaminated fuel	Replace fuel filter Reset pump timing, see FUEL SYSTEMS Replace fuel
Engine Won't Return To Idle	Fast idle adjustment incorrect Internal injection pump malfunction External linkage binding	Reset fast idle, see TUNE-UP Replace injection pump, see FUEL SYSTEMS Check linkage and remove binding
Fuel Leaks On Ground	Loose or broken fuel line Internal injection pump seal leak	Check lines and connections Replace injection pump, see FUEL SYSTEMS
Cylinder Knocking Noise	Injector nozzles sticking open Very low nozzle opening pressure	Test injectors, see FUEL SYSTEMS Test injectors and/or replace
Loss of Engine Power	Restricted air intake EGR valve malfunction Blocked or damaged exhaust system  Blocked fuel tank filter Restricted fuel filter  Block vent in gas cap  Tank-to-injection pump fuel supply blocked Blocked fuel return system Incorrect or contaminated fuel Blocked injector nozzles  Low compression	Remove restriction Replace EGR valve Remove restriction and/or replace components Replace filter Remove restriction and/or replace filter Remove restriction and/or replace cap Check fuel lines and connections Remove restriction Replace fuel  Check nozzle for blockage, see FUEL SYSTEMS Check valves, rings, pistons, see ENGINES
Loud Engine Noise With Black Smoke	Basic timing incorrect EGR valve malfunction Internal injection pump malfunction	Reset timing, see FUEL SYSTEMS Replace EGR valve Replace injection pump, see FUEL SYSTEMS

	Incorrect injector pump housing pressure	Check pressure, see FUEL SYSTEMS
Engine Overheating	Cooling system leaks	Check cooling system and repair leaks
	Belt slipping or damaged	Check tension and/or replace belt
	Thermostat stuck closed	Remove and replace thermostat, see ENGINE COOLING
	Head gasket leaking	Replace head gasket
Oil Light on at Idle	Low oil pump pressure	Check oil pump operation, see ENGINES
	Oil cooler or line restricted	Remove restriction and/or replace cooler
Engine Won't Shut Off	Injector pump fuel solenoid does not return fuel valve to OFF position	Remove and check solenoid and replace if needed
VACUUM PUMP DIAGNOSIS		
Excessive Noise	Loose pump-to-drive assembly screws	Tighten screws
	Loose tube on pump assembly	Tighten tube
	Valves not functioning properly	Replace valves
Oil Leakage	Loose end plug	Tighten end plug
	Bad seal crimp	Remove and re-crimp seal

## FUEL INJECTION TROUBLE SHOOTING

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### BASIC FUEL INJECTION TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start (Crankes Normally)	Cold start valve inoperative	Test valve and circuit
	Poor connection;vacuum or wiring	Check vacuum and electrical connections
	Contaminated fuel	Test fuel for water or alcohol
	Defective fuel pump relay or circuit	Test relay and wiring
	Battery too low	Charge and test battery

	Low fuel pressure	Test pressure regulator and fuel pump, check for restricted lines and filters
	No distributor reference pulses	Repair ignition system as necessary
	Open coolant temperature sensor circuit	Test sensor and wiring
	Shorted W.O.T. switch in T.P.S.	Disconnect W.O.T. switch, engine should start
	Defective ECM	Replace ECM
	Fuel tank residual pressure valve leaks	Test for fuel pressure drop after shut down
Hard Starting	Disconnected hot air tube to air cleaner	Reconnect tube and test control valve
	Defective Idle Air Control (IAC) valve	Test valve operation and circuit
	Shorted, open or misadjusted T.P.S.	Test and adjust or replace T.P.S.
	EGR valve open	Test EGR valve and control circuit
	Poor Oxygen sensor signal	Test for shorted or circuit
	Incorrect mixture from PCV system	Test PCV for flow, check sealing of oil filter cap
Poor High Speed Operation	Low fuel pump volume	Faulty pump or restricted fuel lines or filters
	Poor MAP sensor signal	Test MAP sensor, vacuum hose and wiring
	Poor Oxygen sensor signal	Test for shorted or open sensor or circuit
	Open coolant temperature sensor circuit	Test sensor and wiring
	Faulty ignition operation	Check wires for cracks or poor connections, test secondary voltage with oscilloscope
	Contaminated fuel	Test fuel for water



		or alcohol
	Intermittent ECM ground	Test ECM ground connection for resistance
	Restricted air cleaner	Replace air cleaner
	Restricted exhaust system	Test for exhaust manifold back pressure
	Poor MAF sensor signal	Check leakage between sensor and manifold
	Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
Ping or Knock on Acceleration	Poor Knock sensor signal	Test for shorted or open sensor or circuit
	Poor Baro sensor signal	Test for shorted or open sensor or circuit
	Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
	Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative

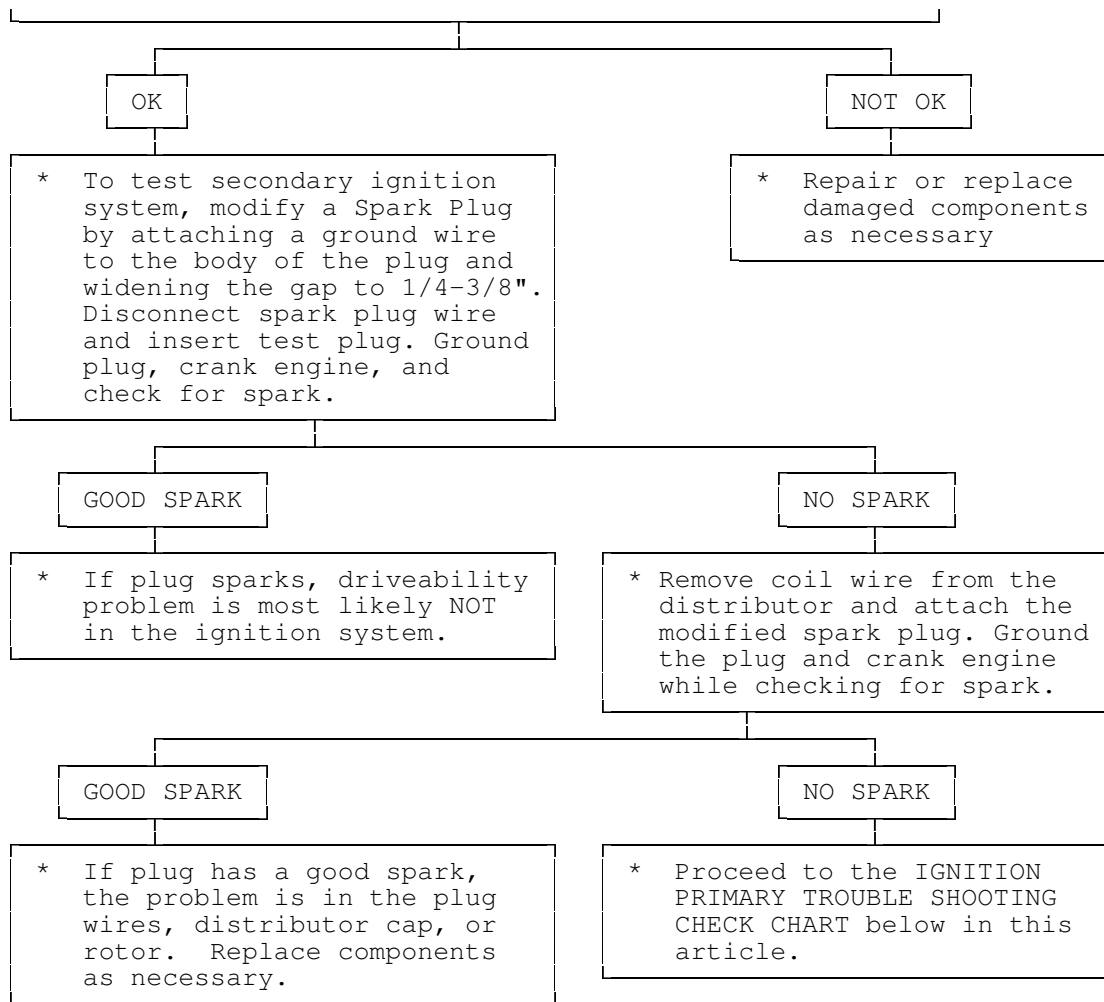
NOTE: For additional electronic fuel injection trouble shooting information, see the appropriate article in the ENGINE PERFORMANCE section (not all vehicles have Computer Engine Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.

## IGNITION SYSTEM TROUBLE SHOOTING

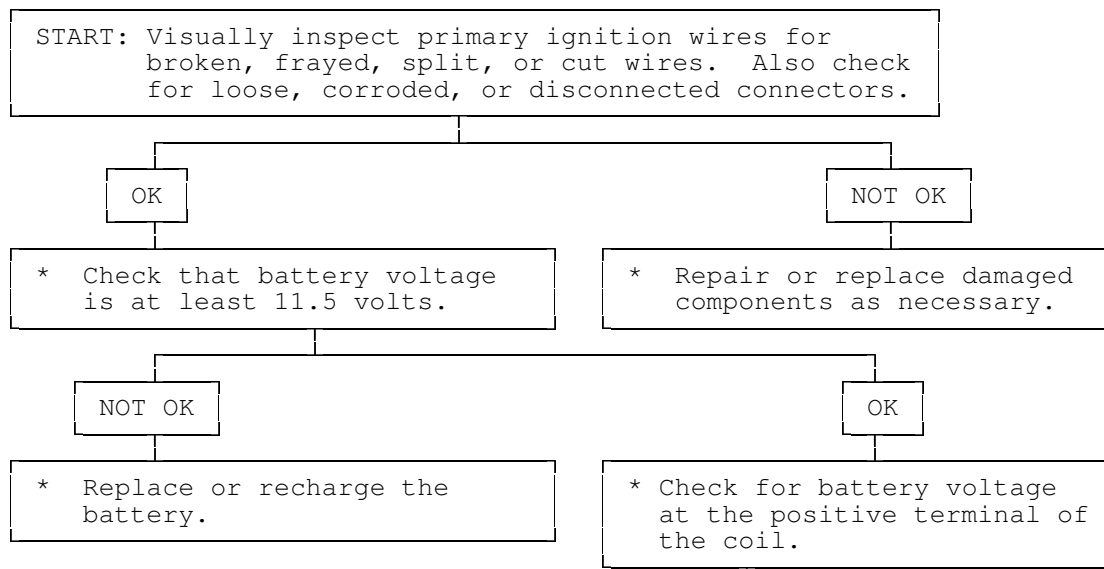
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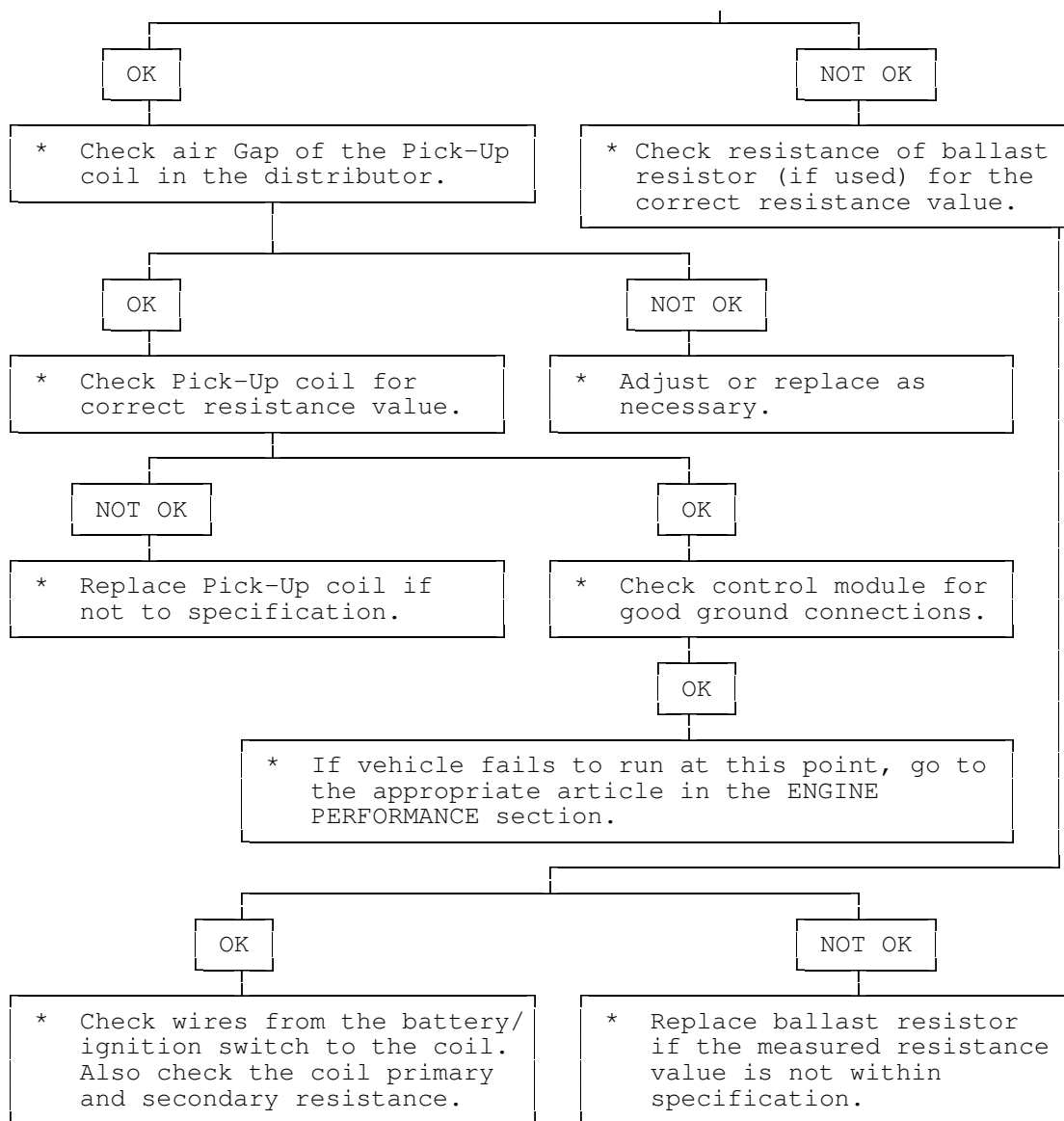
Ignition Secondary Trouble Shooting Chart

<p>START: Visually inspect Spark Plug Wires, Coil Wires, Plug Wire Boots, Rotor, and Distributor Cap for signs of damage.</p>
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Ignition Primary Trouble Shooting Chart





## STARTER TROUBLE SHOOTING

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### BASIC STARTER TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter

	Ignition switch faulty or misadjusted	Adjust or replace ignition switch
	Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
	Starter relay or starter defective	See Testing in STARTER article
	Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	Weak battery or dead cell	Charge or replace battery as necessary
	Loose or corroded battery connections	Check that battery connections are clean and tight
	Internal ground in starter windings	See Testing in STARTER article
	Grounded starter fields	See Testing in STARTERS
	Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	Starter clutch slipping	See STARTER article
	Broken clutch housing	See STARTER article
	Pinion shaft rusted or dry	See STARTER article
	Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
	Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	Faulty overrunning clutch	See STARTER article
	Broken clutch housing	See STARTER article
	Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
	Armature shaft sheared or reduction gear teeth stripped	See STARTER article
	Weak battery	Charge or replace battery as necessary
	Faulty solenoid	See On-Vehicle Tests in STARTER article
	Poor grounds	Check all ground

		connections for tight and clean connections
	Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	Battery weak or defective	Charge or replace battery as necessary
	Engine overheated	See ENGINE COOLING SYSTEM article
	Engine oil too heavy	Check that proper viscosity oil is used
	Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
	Current draw too low or too high	See Bench Tests in STARTER article
	Bent armature, loose pole shoes screws or worn bearings	See STARTER article
	Burned solenoid contacts	Replace solenoid
	Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	Engine timing too far advanced	See Ignition Timing in TUNE-UP article
	Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
	Broken starter clutch	See STARTER article
	Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
	Weak drive assembly thrust spring	See STARTER article
	Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	Defective point assembly	See Testing in STARTER article
	Poor point assembly ground	See Testing in STARTER article
	Defective pull-in coil	Replace starter solenoid
Starter Relay	Dead battery	Charge or replace

Does Not Close		battery as necessary
	Faulty wiring	Check all wiring and connections leading to relay
	Neutral safety switch faulty	Replace neutral safety switch
	Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	Starter motor loose on mountings	Tighten starter attach bolts
	Worn drive end bushing	See STARTER article
	Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
	Drive yolk return spring broken or missing	Replace return spring
	Faulty ignition switch	Replace ignition switch
	Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
	Starter clutch not disengaging	Replace starter clutch
	Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	Faulty solenoid switch, switch connections or	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
	Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	Weak battery	Charge or replace battery as necessary
	Solenoid contacts corroded	Clean contacts or replace solenoid
	Faulty wiring	Check all wiring leading to solenoid
	Broken connections inside switch cover	Repair connections or replace solenoid
	Open hold-in wire	Replace solenoid
Low Current Draw	Worn brushes or weak	Replace brushes or brush springs as necessary

High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	Distance too small between starter pinion and flywheel Flywheel runout contributes to the intermittent nature	

## TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

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### BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

CONDITION	POSSIBLE CAUSE	CORRECTION
Normal Spark Plug Condition	Light Tan or Gray deposits	No Action
	Electrode not burned or fouled	No Action
	Gap tolerance not changed	No Action
Cold Fouling or Carbon Deposits	Overrich air/fuel mixture	Adjust air/fuel mixture, see ENGINE PERFORMANCE section
	Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
	Clogged air filter	Clean and/or replace air filter
	Incorrect idle speed or dirty carburetor	Reset idle speed and/or clean carburetor
	Faulty ignition wires	Replace ignition wiring
	Prolonged operation at idle	Shut engine off during long idle
	Sticking valves or worn valve guide seals	Check valve train
Wet Fouling or Oil Deposits	Worn rings and pistons	Install new rings and pistons

	Excessive cylinder wear	Rebore or replace block
	Excessive valve guide clearance	Worn or loose bearing
Gap Bridged	Deposits in combustion chamber becoming fused to electrode	Clean combustion chamber of deposits
Blistered Electrode	Engine overheating	Check cooling system
	Wrong type of fuel	Replace with correct fuel
	Loose spark plugs	Retighten spark plugs
	Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Pre-Ignition or Melted Electrodes	Incorrect type of fuel	Replace with correct fuel
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Burned valves	Replace valves
	Engine Overheating	Check cooling system
	Wrong type of spark plug, too hot	Replace with correct spark plug, see ENGINE PERFORMANCE
Chipped Insulators	Severe detonation	Check for over-advanced timing or combustion
	Improper gapping procedure	Re-gap spark plugs
Rust Colored Deposits	Additives in unleaded fuel	Try different fuel brand
Water In Combustion Chamber	Blown head gasket or cracked head	Repair or replace head or head gasket

NOTE: Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.

#### BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Won't Start	Open circuit between distributor and bulkhead connector	Repair circuit
	Open circuit between bulkhead connector and	Repair circuit



	ignition switch	
	Open circuit between ignition switch and starter solenoid	Repair circuit
Engine Runs Rough	Fuel lines leaking or clogged	Tighten fitting, remove restriction
	Initial timing incorrect	Reset ignition timing see ENGINE PERFORMANCE
	Centrifugal advance malfunction	Repair distributor advance
	Defective spark plugs or wiring	Replace plugs or plug wiring
Component Failure	Spark arc-over on cap, rotor or coil	Replace cap, rotor or or coil
	Defective pick-up coil	Replace pick-up coil
	Defective ignition coil	Replace ignition coil
	Defective vacuum unit	Replace vacuum unit
	Defective control module	Replace control module

#### BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS - USING OSCILLOSCOPE PATTERNS

CONDITION	POSSIBLE CAUSE	CORRECTION
Firing Voltage Lines are the Same, but Abnormally High	Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
	Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
	High resistance in coil wire	Replace coil wire
	Corrosion in coil tower terminal	Clean and/or replace coil
	Corrosion in distributor coil terminal	Clean and/or replace distributor cap
Firing Voltage Lines are the Same but Abnormally Low	Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
	Breaks in coil wire causing arcing	Replace coil wire
	Cracked coil tower causing arcing	Replace coil
	Low coil output	Replace coil
	Low engine compression	Determine cause and

		repair
One or More, But Not All Firing Voltage Lines are Higher Than Others	Carburetor idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
	EGR valve stuck open	Clean and/or replace valve
	High resistance in spark plug wires	Replace spark plug wires
	Cracked or broken spark plug insulator	Replace spark plugs
	Intake vacuum leak	Repair leak
	Defective spark plugs	Replace spark plugs
	Corroded spark plug terminals	Replace spark plugs
One or More, But Not All Firing Voltage Lines Are Lower Than Others	Carb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
	Breaks in plug wires causing arcing	Replace plug wires
	Cracked coil tower causing arcing	Replace coil
	Low compression	Determine cause and repair
	Defective spark plugs	Replace spark plugs
Cylinders Not Firing	Corroded spark plugs	Replace spark plugs
	Cracked distributor cap terminals	Replace distributor cap
	Shorted spark plug wire	Determine cause and repair
	Mechanical problem in engine	Determine cause and repair
	Defective spark plugs	Replace spark plugs
	Spark plugs fouled	Replace spark plugs

#### BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING TABLE

CONDITION	POSSIBLE CAUSE	CORRECTION
Hard Starting	Binding carburetor linkage	Eliminate binding
	Binding choke linkage	Eliminate binding
	Binding choke piston	Eliminate binding
	Restricted choke vacuum	Check vacuum lines for blockage

	Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
	Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
	Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
	Defective coil	Replace coil
	Improper spark plug gap	Regap spark plugs
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Detonation	Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Defective spark plugs	Replace spark plugs
	Fuel lines clogged	Clean fuel lines
	EGR system malfunction	Check and repair EGR system
	PCV system malfunction	Repair PCV system
	Vacuum leaks	Check and repair vacuum system
	Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE
	Restricted airflow	Remove restriction
	Vacuum advance malfunction	Check distributor operation
Dieseling	Binding carburetor linkage	Eliminate binding
	Binding throttle linkage	Eliminate blinding
	Binding choke linkage or fast idle cam	Eliminate binding
	Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
	Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
Faulty Acceleration	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE

	Engine cold and choke too lean	Adjust choke and allow engine to warm-up
	Defective spark plugs	Replace spark plugs
	Defective coil	Replace coil
Faulty Low Speed Operation	Clogged idle transfer slots	Clean idle transfer slots, see FUEL
	Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
	Clogged air cleaner	Replace air filter
	Defective spark plugs	Replace spark plugs
	Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
	Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Defective distributor centrifugal advance	Replace advance mechanism
	Defective distributor vacuum advance	Replace advance unit
	Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
	Faulty choke operation	Check choke and repair as required
	Clogged vacuum passages	Remove restrictions
	Improper size or clogged main jet	Check jet size and clean, see FUEL
	Restricted air cleaner	Check filter and replace as necessary
	Defective distributor cap, rotor or coil	Replace cap, rotor or coil
Misfire at All Speeds	Defective spark plugs	Replace spark plugs
	Defective spark plug wires	Replace spark plug wires
	Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
	Cracked or broken vacuum hoses	Replace vacuum hoses

	Vacuum leaks	Repair vacuum leaks
	Fuel lines clogged	Remove restriction
Hesitation	Cracked or broken vacuum hoses	Replace vacuum hoses
	Vacuum leaks	Repair Vacuum leaks
	Binding carburetor linkage	Eliminate binding
	Binding throttle linkage	Eliminate binding
	Binding choke linkage or fast idle cam	Eliminate binding
	Improper float setting	Readjust float setting, see FUEL
	Cracked or broken ignition wires	Replace ignition wires
Rough idle, Missing or Stalling	Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
	Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
	Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
	Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
	Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
	Moisture in ignition components	Dry components
	Loose or broken ignition wires	Replace ignition wires
	Damaged distributor cap or or rotor	Replace distributor cap or rotor
	Faulty ignition coil	Replace ignition coil
	Fuel filter clogged or worn	Replace fuel filter
	Damaged idle mixture screw	Replace idle mixture screw, see FUEL
	Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE-see ENGINE PERFORMANCE
	Improper EGR valve operation	Replace EGR valve
	Faulty PCV valve air flow	Replace PCV valve
	Choke binding or improper choke setting	Reset choke or eliminate binding

	Vacuum leak	Repair vacuum leak
	Improper float bowl fuel level	Reset float adjustment, see FUEL
	Clogged air bleed or idle passages	Clean carburetor passages, see FUEL
	Clogged or worn air cleaner filter	Replace air filter
	Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
	Exhaust manifold heat valve inoperative	Replace heat valve
	Improper distributor spark advance	Check distributor operation
	Leaking valves or valve components	Check and repair valvetrain
	Improper carburetor mounting	Remove and remount carburetor
	Excessive play in distributor shaft	Replace distributor
	Loose or corroded wiring connections	Repair or replace as required
Engine Surges	Improper PCV valve airflow	Replace PCV valve
	Vacuum leaks	Repair vacuum leaks
	Clogged air bleeds	Remove restriction
	EGR valve malfunction	Replace EGR valve
	Restricted air cleaner filter	Replace air filter
	Cracked or broken vacuum hoses	Replace vacuum hoses
	Cracked or broken ignition wires	Replace ignition wires
	Vacuum advance malfunction	Check unit and replace as necessary
	Defective or fouled spark plugs	Replace spark plugs
Ping or Spark Knock	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary
	Carburetor setting too lean	Readjust mixture

		setting, see ENGINE PERFORMANCE
	Vacuum leak	Eliminate vacuum leak
	EGR valve malfunction	Replace EGR valve
Poor Gasoline Mileage	Cracked or broken vacuum hoses	Replace vacuum hoses
	Vacuum leaks	Repair vacuum leaks
	Defective ignition wires	Replace wires
	Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
	Defective vacuum advance	Replace vacuum advance
	Defective spark plugs	Replace spark plugs
	Binding carburetor power piston	Eliminate binding
	Dirt in carburetor jets	Clean and/or replace jets
	Incorrect float adjustment	Readjust float setting, see FUEL
	Defective power valve	Replace power valve, see ENGINE PERFORMANCE
	Incorrect idle speed	Readjust idle speed
Engine Stalls	Improper float level	Readjust float level
	Leaking needle valve and seat	Replace needle valve and seat
	Vacuum leaks	Eliminate vacuum leaks

## VACUUM PUMP - DIESEL TROUBLE SHOOTING

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**NOTE:** Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

### VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
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Excessive Noise	Loose pump-to-drive assembly screws	Tighten screws
	Loose tube on pump assembly	Tighten tube
	Valves not functioning properly	Replace valves
Oil Leakage	Loose end plug	Tighten end plug
	Bad seal crimp	Remove and re-crimp seal

## MANUAL TRANSMISSION

### MANUAL TRANSMISSION TROUBLE SHOOTING

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#### MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	.Low gear oil level, .Loose bell housing bolts, .Worn bearings or gears
Clunk On Deceleration (FWD Only)	.Loose engine mounts, .Worn inboard CV joints, .Worn differential pinion shaft, .Side gear hub counterbore in case worn oversize
Gear Clash When Shifting Forward Gears	.Clutch Out Of Adjustment, .Shift linkage damaged or out of adjustment, .Gears or synchronizers damaged, .Low gear oil level
Transmission Noisy When Moving (RWD Only) Quiet In Neutral With Clutch Engaged	.Worn rear outputshaft bearing
Gear Rattle	.Worn bearings, .Wrong gear oil, .Low gear oil, .Worn gears
Steady Ticking At Idle (Increases With RPM)	.Broken tooth on gear
Gear Clash When Shifting Forward Gears	.Worn or broken synchronizers
Loud Whine In Reverse	.Normal condition (1)



Noise When Stepping On Clutch	.Bad release bearing, .Worn pilot bearing
Ticking Or Screeching As Clutch Is Engaged	.Faulty release bearing, .Uneven pressure plate fingers
Click Or Snap When Clutch Is Engaged	.Worn clutch fork, .Worn or broken front bearing retainer
Transmission Shifts Hard	.Clutch not releasing, .Shift mechanism binding, .Clutch installed backwards
Will Not Shift Into One Gear, Shifts Into All Others	.Bent shift fork, .Worn detent balls
Locked Into Gear, Cannot Shift	.Clutch adjustment, .Worn detent balls
Transmission Jumps Out Of Gear	.Pilot bearing worn, .Bent shift fork, .Worn gear teeth or face .Excessive gear train end play .Worn synchronizers .Missing detent ball spring .Shift mechanism worn or out of adjustment .Engine or transmission mount bolts loose or out of adjustment .Transmission not aligned
Shift Lever Rattle	.Worn shift lever or detents .Worn shift forks .Worn synchronizers sleeve
Shift Lever Hops Under Acceleration	.Worn engine or transmission mounts
(1) - Most units use spur cut gears in reverse and are noisy	

## POWERTRAIN

### CLUTCH TROUBLE SHOOTING

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#### BASIC CLUTCH TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Chattering or Grabbing	Incorrect clutch adjustment	Adjust clutch
	Oil, grease or glaze on facings	Disassemble and clean or replace
	Loose "U" joint flange	See DRIVE AXLES article
	Worn input shaft spline	Replace input shaft
	Binding pressure plate	Replace pressure plate
	Binding release lever	See CLUTCH article
	Binding clutch disc hub	Replace clutch disc
	Unequal pressure plate contact	Replace worn/misaligned components
	Loose/bent clutch disc	Replace clutch disc
	Incorrect transmission alignment	Realign transmission
	Worn pressure plate, disc or flywheel	Replace damaged components
	Broken or weak pressure springs	Replace pressure plate
	Sticking clutch pedal	Lubricate clutch pedal & linkage
	Incorrect clutch disc facing	Replace clutch disc
	Engine loose in chassis	Tighten all mounting bolts
Failure to Release	Oil or grease on clutch facings	Clean or replace clutch clutch disc
	Incorrect release lever or pedal adjustment	See CLUTCH article
	Worn or broken clutch facings	Replace clutch disc
	Bent clutch disc or pressure plate	Replace damaged components
	Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
	Binding pilot bearing	Replace pilot bearing
	Sticking release bearing sleeve	Replace release bearing and/or sleeve
	Binding clutch cable	See CLUTCH article

	Defective clutch master	Replace master cylinder
	Defective clutch slave	Replace slave cylinder
	Air in hydraulic system	Bleed hydraulic system
Rattling	Weak or broken release lever spring	Replace spring and check alignment
	Damaged pressure plate	Replace pressure plate
	Broken clutch return spring	Replace return spring
	Worn splines on clutch disc or input shaft	Replace clutch disc and/or input shaft
	Worn clutch release bearing	Replace release bearing
	Dry or worn pilot bearing	Lubricate or replace pilot bearing
	Unequal release lever contact	Align or replace release lever
	Incorrect pedal free play	Adjust free play
	Warped or damaged clutch disc	Replace damaged components
Slipping	Pressure springs worn or	Release pressure plate
	Oily, greasy or worn facings	Clean or replace clutch disc
	Incorrect clutch alignment	Realign clutch assembly
	Warped clutch disc or pressure plate	Replace damaged components
	Binding release levers or clutch pedal	Lubricate and/or replace release components
Squeaking	Worn or damaged release	Replace release bearing
	Dry or worn pilot or release bearing	Lubricate or replace assembly
	Pilot bearing turning in crankshaft	Replace pilot bearing and/or crankshaft
	Worn input shaft bearing	Replace bearing and seal
	Incorrect transmission alignment	Realign transmission
	Dry release fork between pivot	Lubricate release fork and pivot
Heavy and/or Stiff Pedal	Sticking release bearing sleeve	Replace release bearing and/or sleeve

	Dry or binding clutch pedal hub	Lubricate and align components
	Floor mat interference with pedal	Lay mat flat in proper area
	Dry or binding ball/fork pivots	Lubricate and align components
	Faulty clutch cable	Replace clutch cable
Noisy Clutch Pedal	Faulty interlock switch	Replace interlock switch
	Self-adjuster ratchet noise	Lubricate or replace self-adjuster
	Speed control interlock switch	Lubricate or replace interlock switch
Clutch Pedal Sticks Down	Binding clutch cable	See CLUTCH article
	Springs weak in pressure plate	Replace pressure plate
	Binding in clutch linkage	Lubricate and free linkage
Noisy	Dry release bearing	Lubricate or replace release bearing
	Dry or worn pilot bearing	Lubricate or replace bearing
	Worn input shaft bearing	Replace bearing
Transmission Click	Weak springs in pressure plate	Replace pressure plate
	Release fork loose on ball stud	Replace release fork and/or ball stud
	Oil on clutch disc damper	Replace clutch disc
	Broken spring in slave cylinder	Replace slave cylinder

## DRIVE AXLE - NOISE DIAGNOSIS

### Unrelated Noises

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

### Non-Drive Axle Noises

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may sound like gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

#### Gear Noise

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear noise, make sure that tires, exhaust, and vehicle trim have been checked as possible causes.

#### Chuckle

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused by excessive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough the cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

#### Knock

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

#### Clunk

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

- 1) Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.

- 2) On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.

- 3) Measure the length of the chalk mark, which is the total

axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

#### Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

#### Bearing Rumble

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

#### Chatter On Turns

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

#### Axle Shaft Noise

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect axle shafts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

#### Vibration

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can be divided into 3 main groups:

- \* Vibrations of various unbalanced rotating parts of the vehicle.
- \* Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
- \* Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

## DRIVE AXLE - RWD TROUBLE SHOOTING

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### DRIVE AXLE (RWD) TROUBLE SHOOTING

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CONDITION	POSSIBLE CAUSE	CORRECTION
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**Knocking or Clunking**

Differential Side Gear Clearance	Check Clearance
Worn Pinion Shaft	Replace Pinion Shaft
Axle Shaft End Play	Check End Play
Missing Gear Teeth	Check Differential/ Replace Gear
Wrong Axle Backlash	Check Backlash
Misaligned Driveline	Realign Driveline

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**Clinking During Engagement**

Side Gear Clearance	Check Clearance
Ring and Pinion Backlash	Check Backlash
Worn/Loose Pinion Shaft	Replace Shaft/Bearing
Bad "U" Joint	Replace "U" Joint
Sticking Slip Yoke	Lube Slip Yoke
Broken Rear Axle Mount	Replace Mount
Loose Drive Shaft Flange	Check Flange

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**Click/Chatter On Turns**

Differential Side Gear Clearance	Check Clearance
Wrong Turn On Plates (1)	Replace Clutch Plates
Wrong Differential Lubricant (1)	Change Lubricant

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**Knock Or Click**

Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
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**Low Vibration At All Speeds**

Faulty Wheel Bearing	Replace Wheel Bearing
Faulty "U" Joint	Replace "U" Joint
Faulty Drive Shaft	Balance Drive Shaft
Faulty Companion Flange	Replace Flange
Faulty Slip Yoke Flange	Replace Flange

(1) - Limited slip differential only.

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## FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

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problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

#### BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Grease Leaks	CV boot torn or cracked
Clicking Noise on Cornering	Damaged outer CV
Clunk Noise on Acceleration	Damaged inner CV
Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height

## STEERING & SUSPENSION

### MANUAL STEERING GEAR TROUBLE SHOOTING

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#### BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise in Rack and Pinion	Rack and pinion mounting bracket loose	Tighten all mounting bolts
	Lack of/or incorrect lubricant	Correct as necessary
	Steering gear mounting bolts loose	Tighten all mounting bolts
Excessive Play	Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
	Loose or worn steering linkage	See STEERING LINKAGE article
	Loose or worn steering gear shift	See MANUAL STEERING GEAR article
	Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
	Steering gear housing bolts loose	Tighten all mounting bolts
	Steering gear adjustment too loose	See MANUAL STEERING GEAR article
	Steering arms loose on	Tighten and check



	knuckles	steering linkage
	Rack and pinion mounting loose	Tighten all mounting bolts
	Rack and pinion out of adjustment	See adjustment in STEERING article
	Tie rod end loose	Tighten and check steering linkage
	Excessive Pitman shaft-to-ball nut lash	Repair as necessary
Poor Returnability	Lack of lubricant in ball joint or linkage	Lubricate and service systems
	Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article
	Improper front end alignment	See WHEEL ALIGNMENT article
	Improper tire pressure	Inflate to proper pressure
	Tie rod binding	Inflate to proper pressure
	Shaft seal rubbing shaft	See STEERING COLUMN article
Excessive Vertical Motion	Improper tire pressure	Inflate to proper pressure
	Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
	Worn or faulty shock absorbers	Check and replace if necessary
	Loose tie rod ends or steering	Tighten or replace if necessary
	Loose or worn wheel bearings	See SUSPENSION article
Steering Pulls to One Side	Improper tire pressure	Inflate to proper pressure
	Front tires are different sizes	Rotate or replace if necessary
	Wheel bearings not adjusted properly	See FRONT SUSPENSION article
	Bent or broken suspension components	See FRONT SUSPENSION article
	Improper wheel alignment	See WHEEL ALIGNMENT article

	Brakes dragging	See BRAKES article
Instability	Low or uneven tire pressure	Inflate to proper pressure
	Loose or worn wheel bearings	See FRONT SUSPENSION article
	Loose or worn idler arm bushing	See FRONT SUSPENSION article
	Loose or worn strut bushings	See FRONT SUSPENSION article
	Incorrect front wheel alignment	See WHEEL ALIGNMENT article
	Steering gear not centered	See MANUAL STEERING GEARS article
	Springs or shock	Check and replace if necessary
	Improper cross shaft	See MANUAL STEERING GEARS article

## POWER STEERING TROUBLE SHOOTING

**NOTE:** This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

### BASIC POWER STEERING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise	Pressure hoses touching engine parts	Adjust to proper clearance
	Loose Pitman shaft	Adjust or replace if necessary
	Tie rods ends or Pitman arm loose	Tighten and check system
	Rack and pinion mounts loose	Tighten all mounting bolts
	Free play in worm and	See POWER STEERING GEAR article
	Loose sector shaft or thrust bearing adjustment	See POWER STEERING GEAR
	Free play in pot coupling	See STEERING COLUMN article

	Worn shaft serrations	See STEERING COLUMN article
Growl in Steering Pump	Excessive pressure in hoses	Restricted hoses, see POWER STEERING GEAR article
	Scored pressure plates	See POWER STEERING GEAR article
	Scored thrust plates or rotor	See POWER STEERING GEAR article
	Extreme wear of cam ring	See POWER STEERING GEAR article
Rattle in Steering Pump	Vanes not installed	See POWER STEERING PUMP article
	Vanes sticking in rotor	See POWER STEERING PUMP article
Swish noise in Pump	Defective flow control valve	See POWER STEERING PUMP article
Groan in Steering Pump	Air in fluid	See POWER STEERING PUMP article
	Poor pressure hose connection	Tighten and check, replace if necessary
Squawk When Turning	Damper "O" ring on valve spool cut	See POWER STEERING PUMP article
Moan or Whine in Pump	Pump shaft bearing scored	Replace bearing and fluid
	Air in fluid or fluid level low	See POWER STEERING PUMP article
	Hose or column grounded	Check and replace if necessary
	Cover "O" ring missing or damaged	See POWER STEERING PUMP article
	Valve cover baffle missing or damaged	See POWER STEERING PUMP article
	Interference of components in pump	See POWER STEERING PUMP article
	Loose or poor bracket alignment	Correct or replace if necessary
Hissing When Parking	Internal leakage in steering gear	Check valved assembly first
Chirp in Steering Pump	Loose or worn power steering belt	Adjust or replace if necessary
Buzzing When Not Steering	Noisy pump	See POWER STEERING PUMP article

	Free play in steering shaft bearing	See STEERING COLUMN article
	Bearing loose on shaft serrations	See STEERING COLUMN article
Clicking Noise in Pump	Pump slippers too long	See POWER STEERING PUMP article
	Broken slipper springs	See POWER STEERING PUMP article
	Excessive wear or nicked rotors	See POWER STEERING PUMP article
	Damaged cam contour	See POWER STEERING PUMP article
Poor Return of Wheel	Wheel rubbing against turn signal	See STEERING COLUMN SWITCHES article
	Flange rubbing steering gear adjuster	See STEERING COLUMN article
	Tight or frozen steering shaft bearing	See STEERING COLUMN article
	Steering gear out of adjustment	See POWER STEERING GEAR article
	Sticking or plugged spool valve	See POWER STEERING PUMP article
	Improper front end alignment	See WHEEL ALIGNMENT article
	Wheel bearings worn or loose	See FRONT SUSPENSION article
	Ties rods or ball joints binding	Check and replace if necessary
	Intermediate shaft joints binding	See STEERING COLUMN article
	Kinked pressure hoses	Correct or replace if necessary
	Loose housing head spanner nut	See POWER STEERING GEAR article
	Damaged valve lever	See POWER STEERING GEAR article
	Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
	Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
	Reaction ring sticking in cylinder	See POWER STEERING GEAR article

	Reaction ring sticking in housing head	See POWER STEERING GEAR article
	Steering pump internal leakage	See POWER STEERING PUMP article
	Steering gear-to-column misalignment	See STEERING COLUMN article
	Lack of lubrication in linkage	Service front suspension
	Lack of lubrication in ball joints	Service front suspension
Increased Effort When Turning Wheel Fast Foaming, Milky Power Steering Fluid, Low Fluid Level or Low Pressure	High internal pump leakage	See POWER STEERING PUMP article
	Power steering pump belt slipping	Adjust or replace if necessary
	Low fluid level	Check and fill to proper level
	Engine idle speed too low	Adjust to correct setting
	Air in pump fluid system	See POWER STEERING PUMP article
	Pump output low	See POWER STEERING PUMP article
	Steering gear malfunctioning	See POWER STEERING GEAR article
Wheel Surges or Jerks	Low fluid level	Check and fill to proper level
	Loose fan belt	Adjust or replace if necessary
	Insufficient pump pressure	See POWER STEERING PUMP article
	Sticky flow control valve	See POWER STEERING PUMP article
	Linkage hitting oil pan at full turn	Replace bent components
Kick Back or Free Play	Air in pump fluid system	See POWER STEERING PUMP article
	Worn poppet valve in steering gear	See POWER STEERING PUMP article
	Excessive over center lash	See POWER STEERING GEAR article
	Thrust bearing out of adjustment	See POWER STEERING GEAR article

	Free play in pot coupling	See POWER STEERING PUMP article
	Steering gear coupling loose on shaft	See POWER STEERING PUMP article
	Steering disc mounting bolts loose	Tighten or replace if necessary
	Coupling loose on worm shaft	Tighten or replace if necessary
	Improper sector shaft adjustment	See POWER STEERING GEAR article
	Excessive worm piston side play	See POWER STEERING GEAR article
	Damaged valve lever	See POWER STEERING GEAR article
	Universal joint loose	Tighten or replace if necessary
	Defective rotary valve	See POWER STEERING GEAR article
No Power When Parking	Sticking flow control valve	See POWER STEERING PUMP article
	Insufficient pump pressure output	See POWER STEERING PUMP article
	Excessive internal pump leakage	See POWER STEERING PUMP article
	Excessive internal gear leakage	See POWER STEERING PUMP article
	Flange rubs against gear adjust plug	See STEERING COLUMN article
	Loose pump belt	Adjust or replace if necessary
	Low fluid level	Check and add proper amount of fluid
	Engine idle too low	Adjust to correct setting
	Steering gear-to-column misaligned	See STEERING COLUMN article
No Power, Left Turn	Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
	Left turn reaction seal damaged/missing	See POWER STEERING GEAR article
	Cylinder head "O" ring damaged	See POWER STEERING PUMP article

No Power, Right Turns	Column pot coupling bottomed	See STEERING COLUMN article
	Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
	Right turn reaction seal damaged	See POWER STEERING GEAR article
	Internal leakage through piston end plug	See POWER STEERING GEAR article
	Internal leakage through side plugs	See POWER STEERING GEAR article
Lack of Effort in Turning	Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
Wanders to One Side	Front end alignment incorrect	See WHEEL ALIGNMENT article
	Unbalanced steering gear valve	See POWER STEERING GEAR article
Low Pressure Due to Steering Pump	Flow control valve stuck or inoperative	See POWER STEERING PUMP article
	Pressure plate not flat against cam ring	See POWER STEERING PUMP article
	Extreme wear of cam ring	Replace and check adjustments
	Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
	Vanes not installed properly	See POWER STEERING PUMP article
	Vanes sticking in rotor slots	See POWER STEERING PUMP article
	Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article

## STEERING COLUMN TROUBLE SHOOTING

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### BASIC STEERING COLUMN TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Noise in Steering	Coupling pulled apart	See STEERING COLUMNS article

	Column not correctly aligned	See STEERING COLUMNS article
	Broken lower joint	Replace joint
	Horn contact ring not	See STEERING COLUMN article
	Bearing not lubricated	See STEERING COLUMN article
	Shaft snap ring not properly seated	Reseat or replace snap ring
	Plastic spherical joint not lubricated	See STEERING COLUMN article
	Shroud or housing loose	Tighten holding screws
	Lock plate retaining ring not seated	See STEERING COLUMN article
	Loose sight shield	Tighten holding screws
High Steering Shaft Effort	Column assembly misaligned	See STEERING COLUMN article
	Improperly installed dust shield	Adjust or replace
	Tight steering universal joint	See STEERING COLUMN article
High Shift Effort	Column is out of alignment	See STEERING COLUMN article
	Improperly installed dust shield	Adjust or replace
	Seals or bearings not lubricated	See STEERING COLUMNS article
	Mounting bracket screws too long	Replace with new shorter screws
	Burrs on shift tube	Remove burrs or replace tube
	Lower bowl bearing assembled wrong	See STEERING COLUMN article
	Shift tube bent or broken	Replace as necessary
Improper Trans. Shifting	Improper adjustment of shift levers	See STEERING COLUMN article
	Sheared shift tube joint	Replace as necessary
	Sheared lower shaft lever	Replace as necessary
	Improper shift lever adjustment	See STEERING COLUMN article



	Improper gate plate adjustment	See STEERING COLUMN article
Excess Play in Column	Instrument panel bracket bolts loose	Tighten bolts and check bracket
	Broken weld nut on jacket	See STEERING COLUMN article
	Instrument bracket capsule sheared	See STEERING COLUMN article
	Column bracket/jacket bolts loose	Tighten bolts and check bracket
Steering Locks in Gear	Release lever mechanism	See STEERING COLUMN article

## SUSPENSION TROUBLE SHOOTING

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### BASIC SUSPENSION TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Front End Noise	Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
	Worn shocks or shock mountings	Replace struts or strut mountings
	Worn struts or strut mountings	Replace struts or strut mountings
	Loose or worn lower control arm	See SUSPENSION
	Loose steering gear-to-frame bolts	See STEERING
	Worn control arm bushings	See SUSPENSION
	Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
Front Wheel Shake, Shimmy, or Vibration	Tires or wheels out of balance	Check tire balance
	Incorrect wheel alignment	See WHEEL ALIGNMENT
	Drive shaft unbalanced	Check drive shaft balance

	Loose or worn wheel bearings	See WHEEL ALIGNMENT
	Loose or worn tie rod ends	See SUSPENSION
	Worn upper ball joints	See Ball Joint Checking in SUSPENSION
	Worn shock absorbers	Replace shock absorbers
	Worn strut bushings	Replace strut bushings
Car Pulls to One Side	Mismatched or uneven tires	Check tire condition
	Broken or sagging springs	See SUSPENSION
	Loose or worn strut bushings	See SUSPENSION
	Improper wheel alignment	See WHEEL ALIGNMENT
	Improper rear axle alignment	Check rear axle alignment
	Power steering gear unbalanced	See STEERING
	Front brakes dragging	See BRAKES
Abnormal Tire Wear	Unbalanced tires	Check tire balance & rotation
	Sagging or broken springs	See SUSPENSION
	Incorrect front end alignment	See WHEEL ALIGNMENT
	Faulty shock absorbers	Replace chock absorbers
Scuffed Tires	Toe-In incorrect	See WHEEL ALIGNMENT
	Suspension arm bent or twisted	See appropriate SUSPENSION article
Springs Bottom or Sag	Bent or broken springs	See SUSPENSION
	Leaking or worn shock absorbers	Replace shock absorbers
	Frame misalignment	Check frame for damage
Spring Noises	Loose "U" Bolts	See SUSPENSION
	Loose or worn bushings	See SUSPENSION
	Worn or missing interliners	See SUSPENSION
Shock Absorber Noise	Loose shock mountings	Check & tighten mountings
	Worn bushings	Replace bushings

	Air in system	Bleed air from system
	Undercoating on shocks	Remove undercoating
Car Leans or Sways on Corners	Loose stabilizer bar	See SUSPENSION
	Faulty shocks or mountings	Replace shocks or mountings
	Broken or sagging springs	See SUSPENSION
Shock Absorbers Leaking	Worn seals or reservoir tube crimped	See SUSPENSION
Broken Springs	Loose "U" bolts	See SUSPENSION
	Inoperative shock absorbers	Replace shock absorbers

## WHEEL ALIGNMENT TROUBLE SHOOTING

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### BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Premature Tire Wear	Improper tire inflation	Check tire pressure
	Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
	Suspension components worn	See SUSPENSION section
	Steering system components worn	See STEERING section
	Improper standing height	See WHEEL ALIGNMENT
	Uneven or sagging springs	See SUSPENSION section
	Bent wheel	See WHEEL ALIGNMENT
	Improper torsion bar adjustment	See SUSPENSION section
	Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section
	Worn or defective shock	Replace shock absorbers
	Tires out of balance	Check tire balance
Pulls to One Side	Improper tire inflation	Check tire pressure
	Brake dragging	See BRAKE section

	Mismatched tires	See WHEEL ALIGNMENT
	Broken or sagging spring	See SUSPENSION section
	Broken torsion bar	See SUSPENSION section
	Power steering valve not centered	See STEERING section
	Front alignment out of tolerance	See WHEEL ALIGNMENT section
	Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
	Uneven sway bar links	See SUSPENSION section
	Frame bent	Check for frame damage
	Steering system bushing worn	See STEERING section
Hard Steering	Idler arm bushing too tight	See STEERING LINKAGE in STEERING section
	Ball joint tight or seized	See SUSPENSION section
	Steering linkage too tight	See STEERING LINKAGE in STEERING section
	Power steering fluid low	Add proper amount of fluid
	Power steering drive belt loose	See STEERING section
	Power steering pump defective	See STEERING section
	Steering gear out of adjustment	See STEERING section
	Incorrect wheel alignment	See WHEEL ALIGNMENT
	Damaged steering gear	See STEERING section
	Damaged suspension	See SUSPENSION section
Vehicle "Wanders"	Bent steering knuckle or supports	See SUSPENSION section
	Strut rod or control arm bushing worn	See SUSPENSION section
	Loose or worn wheel bearings	See WHEEL BEARINGS in SUSPENSION section
	Improper tire inflation	Check tire pressure
	Stabilizer bar missing or defective	See SUSPENSION section

	Wheel alignment out of tolerance	See Adjustment in WHEEL ALIGNMENT section
	Broken spring	See SUSPENSION section
	Defective shock absorbers	Replace shock absorbers
	Worn steering & suspension components	See SUSPENSION section
Front End Shimmy	Tire out of balance/round	Check tire balance
	Excessive wheel runout	See WHEEL ALIGNMENT
	Insufficient or improper caster	See WHEEL ALIGNMENT section
	Worn suspension or steering components	See SUSPENSION section
	Defective shock absorbers	Replace shock absorber
	Wheel bearings worn or loose	See WHEEL BEARING ADJ. in SUSPENSION section
	Power steering reaction Bracket loose	See STEERING section
	Steering gear box (rack) mounting loose	See STEERING section
	Steering gear adjustment loose	See STEERING section
	Worn spherical joints	See SUSPENSION section
Toe-In Not Adjustable	Lower control arm bent	See SUSPENSION section
	Frame bent	Check frame for damage
Camber Not Adjustable	Control arm bent	See SUSPENSION section
	Frame bent	Check frame for damage
	Hub & bearing not seated properly	See SUSPENSION section

# WAVEFORMS - INJECTOR PATTERN TUTORIAL

1993 Jeep Cherokee

## GENERAL INFORMATION

Waveforms - Injector Pattern Tutorial

### \* PLEASE READ THIS FIRST \*

NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models.

### PURPOSE OF THIS ARTICLE

Learning how to interpret injector drive patterns from a Lab Scope can be like learning ignition patterns all over again. This article exists to ease you into becoming a skilled injector pattern interpreter.

You will learn:

- \* How a DVOM and noid light fall short of a lab scope.
- \* The two types of injector driver circuits, voltage controlled & current controlled.
- \* The two ways injector circuits can be wired, constant ground/switched power & constant power/switched ground.
- \* The two different pattern types you can use to diagnose with, voltage & current.
- \* All the valuable details injector patterns can reveal.

### SCOPE OF THIS ARTICLE

This is NOT a manufacturer specific article. All different types of systems are covered here, regardless of the specific year/make/model/engine.

The reason for such broad coverage is because there are only a few basic ways to operate a solenoid-type injector. By understanding the fundamental principles, you will understand all the major points of injector patterns you encounter. Of course there are minor differences in each specific system, but that is where a waveform library helps out.

If this is confusing, consider a secondary ignition pattern. Even though there are many different implementations, each still has a primary voltage turn-on, firing line, spark line, etc.

If specific waveforms are available in On Demand for the engine and vehicle you are working on, you will find them in the Engine Performance section under the Engine Performance category.

### IS A LAB SCOPE NECESSARY?

#### INTRODUCTION

You probably have several tools at your disposal to diagnose injector circuits. But you might have questioned "Is a lab scope necessary to do a thorough job, or will a set of noid lights and a multifunction DVOM do just as well?"

In the following text, we are going to look at what noid lights and DVOMs do best, do not do very well, and when they can mislead you. As you might suspect, the lab scope, with its ability to look inside an active circuit, comes to the rescue by answering for the deficiencies of these other tools.

#### OVERVIEW OF NOID LIGHT

The noid light is an excellent "quick and dirty" tool. It can usually be hooked to a fuel injector harness fast and the flashing light is easy to understand. It is a dependable way to identify a no-pulse situation.

However, a noid light can be very deceptive in two cases:

- \* If the wrong one is used for the circuit being tested.  
Beware: Just because a connector on a noid light fits the harness does not mean it is the right one.
- \* If an injector driver is weak or a minor voltage drop is present.

Use the Right Noid Light

In the following text we will look at what can happen if the wrong noid light is used, why there are different types of noid lights (besides differences with connectors), how to identify the types of noid lights, and how to know the right type to use.

First, let's discuss what can happen if the incorrect type of noid light is used. You might see:

- \* A dimly flashing light when it should be normal.
- \* A normal flashing light when it should be dim.

A noid light will flash dim if used on a lower voltage circuit than it was designed for. A normally operating circuit would appear underpowered, which could be misinterpreted as the cause of a fuel starvation problem.

Here are the two circuit types that could cause this problem:

- \* Circuits with external injector resistors. Used predominately on some Asian & European systems, they are used to reduce the available voltage to an injector in order to limit the current flow. This lower voltage can cause a dim flash on a noid light designed for full voltage.
- \* Circuits with current controlled injector drivers (e.g. "Peak and Hold"). Basically, this type of driver allows a quick burst of voltage/current to flow and then throttles it back significantly for the remainder of the pulse width duration. If a noid light was designed for the other type of driver (voltage controlled, e.g. "Saturated"), it will appear dim because it is expecting full voltage/current to flow for the entire duration of the pulse width.

Let's move to the other situation where a noid light flashes normally when it should be dim. This could occur if a more sensitive noid light is used on a higher voltage/amperage circuit that was weakened enough to cause problems (but not outright broken). A circuit with an actual problem would thus appear normal.

Let's look at why. A noid light does not come close to consuming as much amperage as an injector solenoid. If there is a partial driver failure or a minor voltage drop in the injector circuit, there can be adequate amperage to fully operate the noid light BUT NOT ENOUGH TO OPERATE THE INJECTOR.

If this is not clear, picture a battery with a lot of corrosion on the terminals. Say there is enough corrosion that the starter motor will not operate; it only clicks. Now imagine turning on the headlights (with the ignition in the RUN position). You find they light normally and are fully bright. This is the same idea as noid light: There is a problem, but enough amp flow exists to operate the headlights ("noid light"), but not the starter motor ("injector").

How do you identify and avoid all these situations? By using the correct type of noid light. This requires that you understanding

the types of injector circuits that your noid lights are designed for. There are three. They are:

- \* Systems with a voltage controlled injector driver. Another way to say it: The noid light is designed for a circuit with a "high" resistance injector (generally 12 ohms or above).
- \* Systems with a current controlled injector driver. Another way to say it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) without an external injector resistor.
- \* Systems with a voltage controlled injector driver and an external injector resistor. Another way of saying it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) and an external injector resistor.

NOTE: Some noid lights can meet both the second and third categories simultaneously.

If you are not sure which type of circuit your noid light is designed for, plug it into a known good car and check out the results. If it flashes normally during cranking, determine the circuit type by finding out injector resistance and if an external injector resistor is used. You now know enough to identify the type of injector circuit. Label the noid light appropriately.

Next time you need to use a noid light for diagnosis, determine what type of injector circuit you are dealing with and select the appropriate noid light.

Of course, if you suspect a no-pulse condition you could plug in any one whose connector fit without fear of misdiagnosis. This is because it is unimportant if the flashing light is dim or bright. It is only important that it flashes.

In any cases of doubt regarding the use of a noid light, a lab scope will overcome all inherent weaknesses.

## OVERVIEW OF DVOM

A DVOM is typically used to check injector resistance and available voltage at the injector. Some techs also use it check injector on-time either with a built-in feature or by using the dwell/duty function.

There are situations where the DVOM performs these checks dependably, and other situations where it can deceive you. It is important to be aware of these strengths and weaknesses. We will cover the topics above in the following text.

### Checking Injector Resistance

If a short in an injector coil winding is constant, an ohmmeter will accurately identify the lower resistance. The same is true with an open winding. Unfortunately, an intermittent short is an exception. A faulty injector with an intermittent short will show "good" if the ohmmeter cannot force the short to occur during testing.

Alcohol in fuel typically causes an intermittent short, happening only when the injector coil is hot and loaded by a current high enough to jump the air gap between two bare windings or to break down any oxides that may have formed between them.

When you measure resistance with an ohmmeter, you are only applying a small current of a few milliamps. This is nowhere near enough to load the coil sufficiently to detect most problems. As a result, most resistance checks identify intermittently shorted injectors as being normal.

There are two methods to get around this limitation. The first is to purchase a tool that checks injector coil windings under



full load. The Kent-Moore J-39021 is such a tool, though there are others. The Kent-Moore costs around \$240 at the time of this writing and works on many different manufacturer's systems.

The second method is to use a lab scope. Remember, a lab scope allows you to see the regular operation of a circuit in real time. If an injector is having an short or intermittent short, the lab scope will show it.

#### Checking Available Voltage At the Injector

Verifying a fuel injector has the proper voltage to operate correctly is good diagnostic technique. Finding an open circuit on the feed circuit like a broken wire or connector is an accurate check with a DVOM. Unfortunately, finding an intermittent or excessive resistance problem with a DVOM is unreliable.

Let's explore this drawback. Remember that a voltage drop due to excessive resistance will only occur when a circuit is operating? Since the injector circuit is only operating for a few milliseconds at a time, a DVOM will only see a potential fault for a few milliseconds. The remaining 90+% of the time the unloaded injector circuit will show normal battery voltage.

Since DVOMs update their display roughly two to five times a second, all measurements in between are averaged. Because a potential voltage drop is visible for such a small amount of time, it gets "averaged out", causing you to miss it.

Only a DVOM that has a "min-max" function that checks EVERY MILLISECOND will catch this fault consistently (if used in that mode). The Fluke 87 among others has this capability.

A "min-max" DVOM with a lower frequency of checking (100 millisecond) can miss the fault because it will probably check when the injector is not on. This is especially true with current controlled driver circuits. The Fluke 88, among others fall into this category.

Outside of using a Fluke 87 (or equivalent) in the 1 mS "min-max" mode, the only way to catch a voltage drop fault is with a lab scope. You will be able to see a voltage drop as it happens.

One final note. It is important to be aware that an injector circuit with a solenoid resistor will always show a voltage drop when the circuit is energized. This is somewhat obvious and normal; it is a designed-in voltage drop. What can be unexpected is what we already covered--a voltage drop disappears when the circuit is unloaded. The unloaded injector circuit will show normal battery voltage at the injector. Remember this and do not get confused.

#### Checking Injector On-Time With Built-In Function

Several DVOMs have a feature that allows them to measure injector on-time (mS pulse width). While they are accurate and fast to hookup, they have three limitations you should be aware of:

- \* They only work on voltage controlled injector drivers (e.g "Saturated Switch"), NOT on current controlled injector drivers (e.g. "Peak & Hold").
- \* A few unusual conditions can cause inaccurate readings.
- \* Varying engine speeds can result in inaccurate readings.

Regarding the first limitation, DVOMs need a well-defined injector pulse in order to determine when the injector turns ON and OFF. Voltage controlled drivers provide this because of their simple switch-like operation. They completely close the circuit for the entire duration of the pulse. This is easy for the DVOM to interpret.

The other type of driver, the current controlled type, start off well by completely closing the circuit (until the injector pintle opens), but then they throttle back the voltage/current for the duration of the pulse. The DVOM understands the beginning of the pulse

but it cannot figure out the throttling action. In other words, it cannot distinguish the throttling from an open circuit (de-energized) condition.

Yet current controlled injectors will still yield a millisecond on-time reading on these DVOMs. You will find it is also always the same, regardless of the operating conditions. This is because it is only measuring the initial completely-closed circuit on-time, which always takes the same amount of time (to lift the injector pintle off its seat). So even though you get a reading, it is useless.

The second limitation is that a few erratic conditions can cause inaccurate readings. This is because of a DVOM's slow display rate; roughly two to five times a second. As we covered earlier, measurements in between display updates get averaged. So conditions like skipped injector pulses or intermittent long/short injector pulses tend to get "averaged out", which will cause you to miss important details.

The last limitation is that varying engine speeds can result in inaccurate readings. This is caused by the quickly shifting injector on-time as the engine load varies, or the RPM moves from a state of acceleration to stabilization, or similar situations. It too is caused by the averaging of all measurements in between DVOM display periods. You can avoid this by checking on-time when there are no RPM or load changes.

A lab scope allows you to overcome each one of these limitations.

#### Checking Injector On-Time With Dwell Or Duty

If no tool is available to directly measure injector millisecond on-time measurement, some techs use a simple DVOM dwell or duty cycle functions as a replacement.

While this is an approach of last resort, it does provide benefits. We will discuss the strengths and weaknesses in a moment, but first we will look at how a duty cycle meter and dwell meter work.

#### How A Duty Cycle Meter and Dwell Meter Work

All readings are obtained by comparing how long something has been OFF to how long it has been ON in a fixed time period. A dwell meter and duty cycle meter actually come up with the same answers using different scales. You can convert freely between them. See RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE.

The DVOM display updates roughly one time a second, although some DVOMs can be a little faster or slower. All measurements during this update period are tallied inside the DVOM as ON time or OFF time, and then the total ratio is displayed as either a percentage (duty cycle) or degrees (dwell meter).

For example, let's say a DVOM had an update rate of exactly 1 second (1000 milliseconds). Let's also say that it has been measuring/tallying an injector circuit that had been ON a total of 250 mS out of the 1000 mS. That is a ratio of one-quarter, which would be displayed as 25% duty cycle or 15° dwell (six-cylinder scale). Note that most duty cycle meters can reverse the readings by selecting the positive or negative slope to trigger on. If this reading were reversed, a duty cycle meter would display 75%.

#### Strengths of Dwell/Duty Meter

The obvious strength of a dwell/duty meter is that you can compare injector on-time against a known-good reading. This is the only practical way to use a dwell/duty meter, but requires you to have known-good values to compare against.

Another strength is that you can roughly convert injector mS on-time into dwell reading with some computations.

A final strength is that because the meter averages everything together it does not miss anything (though this is also a

severe weakness that we will look at later). If an injector has a fault where it occasionally skips a pulse, the meter registers it and the reading changes accordingly.

Let's go back to figuring out dwell/duty readings by using injector on-time specification. This is not generally practical, but we will cover it for completeness. You NEED to know three things:

- \* Injector mS on-time specification.
- \* Engine RPM when specification is valid.
- \* How many times the injectors fire per crankshaft revolution.

The first two are self-explanatory. The last one may require some research into whether it is a bank-fire type that injects every 360° of crankshaft rotation, a bank-fire that injects every 720°, or an SFI that injects every 720°. Many manufacturers do not release this data so you may have to figure it out yourself with a frequency meter.

Here are the four complete steps to convert millisecond on-time:

1) Determine the injector pulse width and RPM it was obtained at. Let's say the specification is for one millisecond of on-time at a hot idle of 600 RPM.

2) Determine injector firing method for the complete 4 stroke cycle. Let's say this is a 360° bank-fired, meaning an injector fires each and every crankshaft revolution.

3) Determine how many times the injector will fire at the specified engine speed (600 RPM) in a fixed time period. We will use 100 milliseconds because it is easy to use.

Six hundred crankshaft Revolutions Per Minute (RPM) divided by 60 seconds equals 10 revolutions per second.

Multiplying 10 times .100 yields one; the crankshaft turns one time in 100 milliseconds. With exactly one crankshaft rotation in 100 milliseconds, we know that the injector fires exactly one time.

4) Determine the ratio of injector on-time vs. off-time in the fixed time period, then figure duty cycle and/or dwell. The injector fires one time for a total of one millisecond in any given 100 millisecond period.

One hundred minus one equals 99. We have a 99% duty cycle. If we wanted to know the dwell (on 6 cylinder scale), multiple 99% times .6; this equals 59.4° dwell.

#### Weaknesses of Dwell/Duty Meter

The weaknesses are significant. First, there is no one-to-one correspondence to actual mS on-time. No manufacturer releases dwell/duty data, and it is time-consuming to convert the mS on-time readings. Besides, there can be a large degree of error because the conversion forces you to assume that the injector(s) are always firing at the same rate for the same period of time. This can be a dangerous assumption.

Second, all level of detail is lost in the averaging process. This is the primary weakness. You cannot see the details you need to make a confident diagnosis.

Here is one example. Imagine a vehicle that has a faulty injector driver that occasionally skips an injector pulse. Every skipped pulse means that that cylinder does not fire, thus unburned O2 gets pushed into the exhaust and passes the O2 sensor. The O2 sensor indicates lean, so the computer fattens up the mixture to compensate for the supposed "lean" condition.

A connected dwell/duty meter would see the fattened pulse width but would also see the skipped pulses. It would tally both and likely come back with a reading that indicated the "pulse width" was within specification because the rich mixture and missing pulses offset each other.

This situation is not a far-fetched scenario. Some early GM

3800 engines were suffering from exactly this. The point is that a lack of detail could cause misdiagnosis.  
As you might have guessed, a lab scope would not miss this.

RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE (1)

Dwell Meter (2)	Duty Cycle Meter
1° .....	1%
15° .....	25%
30° .....	50%
45° .....	75%
60° .....	100%

- (1) - These are just some examples for your understanding.  
It is okay to fill in the gaps.  
(2) - Dwell meter on the six-cylinder scale.

## THE TWO TYPES OF INJECTOR DRIVERS

### OVERVIEW

There are two types of transistor driver circuits used to operate electric fuel injectors: voltage controlled and current controlled. The voltage controlled type is sometimes called a "saturated switch" driver, while the current controlled type is sometimes known as a "peak and hold" driver.

The basic difference between the two is the total resistance of the injector circuit. Roughly speaking, if a particular leg in an injector circuit has total resistance of 12 or more ohms, a voltage control driver is used. If less than 12 ohms, a current control driver is used.

It is a question of what is going to do the job of limiting the current flow in the injector circuit; the inherent "high" resistance in the injector circuit, or the transistor driver. Without some form of control, the current flow through the injector would cause the solenoid coil to overheat and result in a damaged injector.

### VOLTAGE CONTROLLED CIRCUIT ("SATURATED SWITCH")

The voltage controlled driver inside the computer operates much like a simple switch because it does not need to worry about limiting current flow. Recall, this driver typically requires injector circuits with a total leg resistance of 12 or more ohms.

The driver is either ON, closing/completing the circuit (eliminating the voltage-drop), or OFF, opening the circuit (causing a total voltage drop).

Some manufacturers call it a "saturated switch" driver. This is because when switched ON, the driver allows the magnetic field in the injector to build to saturation. This is the same "saturation" property that you are familiar with for an ignition coil.

There are two ways "high" resistance can be built into an injector circuit to limit current flow. One method uses an external solenoid resistor and a low resistance injector, while the other uses a high resistance injector without the solenoid resistor. See the left side of Fig. 1.

In terms of injection opening time, the external resistor voltage controlled circuit is somewhat faster than the voltage controlled high resistance injector circuit. The trend, however, seems to be moving toward use of this latter type of circuit due to its lower cost and reliability. The ECU can compensate for slower opening

times by increasing injector pulse width accordingly.

**NOTE:** Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

### VOLTAGE-CONTROLLED TYPE

### CURRENT-CONTROLLED TYPE

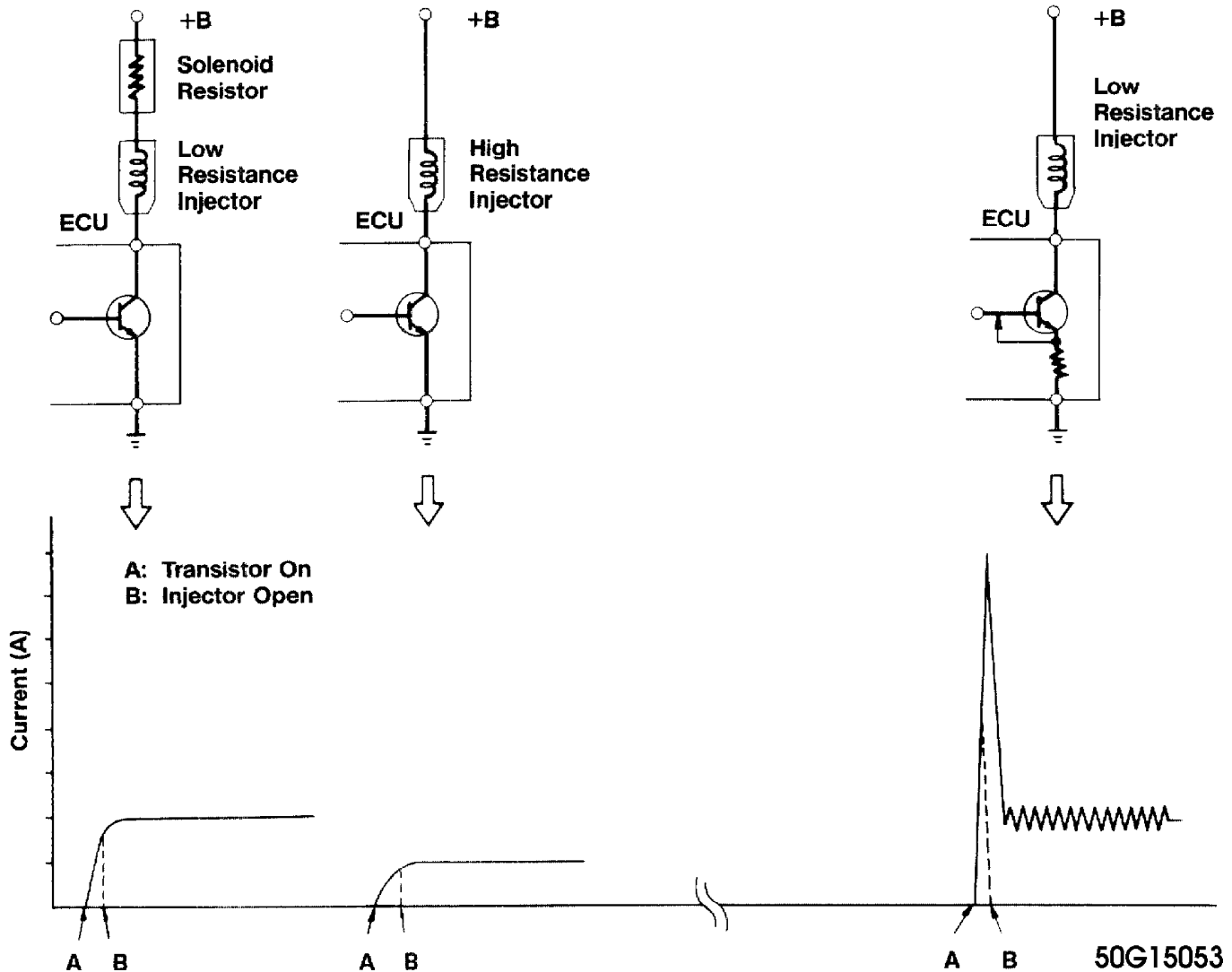


Fig. 1: Injector Driver Types - Current and Voltage

### CURRENT CONTROLLED CIRCUIT ("PEAK & HOLD")

The current controlled driver inside the computer is more complex than a voltage controlled driver because as the name implies, it has to limit current flow in addition to its ON-OFF switching function. Recall, this driver typically requires injector circuits with a total leg resistance of less than 12 ohms.

Once the driver is turned ON, it will not limit current flow until enough time has passed for the injector pintle to open. This period is preset by the particular manufacturer/system based on the amount of current flow needed to open their injector. This is typically between two and six amps. Some manufacturers refer to this

as the "peak" time, referring to the fact that current flow is allowed to "peak" (to open the injector).

Once the injector pintle is open, the amp flow is considerably reduced for the rest of the pulse duration to protect the injector from overheating. This is okay because very little amperage is needed to hold the injector open, typically in the area of one amp or less. Some manufacturers refer to this as the "hold" time, meaning that just enough current is allowed through the circuit to "hold" the already-open injector open.

There are a couple methods of reducing the current. The most common trims back the available voltage for the circuit, similar to turning down a light at home with a dimmer.

The other method involves repeatedly cycling the circuit ON-OFF. It does this so fast that the magnetic field never collapses and the pintle stays open, but the current is still significantly reduced. See the right side of Fig. 1 for an illustration.

The advantage to the current controlled driver circuit is the short time period from when the driver transistor goes ON to when the injector actually opens. This is a function of the speed with which current flow reaches its peak due to the low circuit resistance. Also, the injector closes faster when the driver turns OFF because of the lower holding current.

**NOTE:** Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

## **THE TWO WAYS INJECTOR CIRCUITS ARE WIRED**

Like other circuits, injector circuits can be wired in one of two fundamental directions. The first method is to steadily power the injectors and have the computer driver switch the ground side of the circuit. Conversely, the injectors can be steadily grounded while the driver switches the power side of the circuit.

There is no performance benefit to either method. Voltage controlled and current controlled drivers have been successfully implemented both ways.

However, 95% percent of the systems are wired so the driver controls the ground side of the circuit. Only a handful of systems use the drivers on the power side of the circuit. Some examples of the latter are the 1970's Cadillac EFI system, early Jeep 4.0 EFI (Renix system), and Chrysler 1984-87 TBI.

## **INTERPRETING INJECTOR WAVEFORMS**

### **INTERPRETING A VOLTAGE CONTROLLED PATTERN**

**NOTE:** Voltage controlled drivers are also known as "Saturated Switch" drivers. They typically require injector circuits with a total leg resistance of 12 ohms or more.

**NOTE:** This example is based on a constant power/switched ground circuit.

\* See Fig. 2 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you

will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This can occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Note that circuits with external injector resistors will not be any different because the resistor does not affect open circuit voltage.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

The points between "B" and "D" represent the time in milliseconds that the injector is being energized or held open. This line at Point "C" should remain flat. Any distortion or upward bend indicates a ground problem, short problem, or a weak driver. Alert readers will catch that this is exactly opposite of the current controlled type drivers (explained in the next section), because they bend upwards at this point.

How come the difference? Because of the total circuit resistance. Voltage controlled driver circuits have a high resistance of 12+ ohms that slows the building of the magnetic field in the injector. Hence, no counter voltage is built up and the line remains flat.

On the other hand, the current controlled driver circuit has low resistance which allows for a rapid magnetic field build-up. This causes a slight inductive rise (created by the effects of counter voltage) and hence, the upward bend. You should not see that here with voltage controlled circuits.

Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts at the top of Point "D".

If you do see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning the injector has a weak winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

Point "E" brings us to a very interesting section. As you can see, the voltage dissipates back to supply value after the peak of the inductive kick. Notice the slight hump? This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking because of a faulty injector

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.



## INTERPRETING A CURRENT CONTROLLED PATTERN

NOTE: Current controlled drivers are also known as "Peak and Hold"



drivers. They typically require injector circuits with a total leg resistance with less than 12 ohm.

NOTE: This example is based on a constant power/switched ground circuit.

\* See Fig. 3 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This could occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

Right after Point "C", something interesting happens. Notice the trace starts a normal upward bend. This slight inductive rise is created by the effects of counter voltage and is normal. This is because the low circuit resistance allowed a fast build-up of the magnetic field, which in turn created the counter voltage.

Point "D" is the start of the current limiting, also known as the "Hold" time. Before this point, the driver had allowed the current to free-flow ("Peak") just to get the injector pintle open. By the time point "D" occurs, the injector pintle has already opened and the computer has just significantly throttled the current back. It does this by only allowing a few volts through to maintain the minimum current required to keep the pintle open.

The height of the voltage spike seen at the top of Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts.

If you see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning there is a problem with a weak injector winding.

If a zener diode is not used in the computer, the spike from

a good injector will be 60 or more volts.

At Point "E", notice that the trace is now just a few volts below system voltage and the injector is in the current limiting, or the "Hold" part of the pattern. This line will either remain flat and stable as shown here, or will cycle up and down rapidly. Both are normal methods to limit current flow. Any distortion may indicate shorted windings.

Point "F" is the actual turn-off point of the driver (and injector). To measure the millisecond on-time of the injector, measure between points "C" and "F". Note that we used cursors to do it for us; they are measuring a 2.56 mS on-time.

The top of Point "F" (second inductive kick) is created by the collapsing magnetic field caused by the final turn-off of the driver. This spike should be like the spike on top of point "D".

Point "G" shows a slight hump. This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking. Some older Nissan TBI systems suffered from this.

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

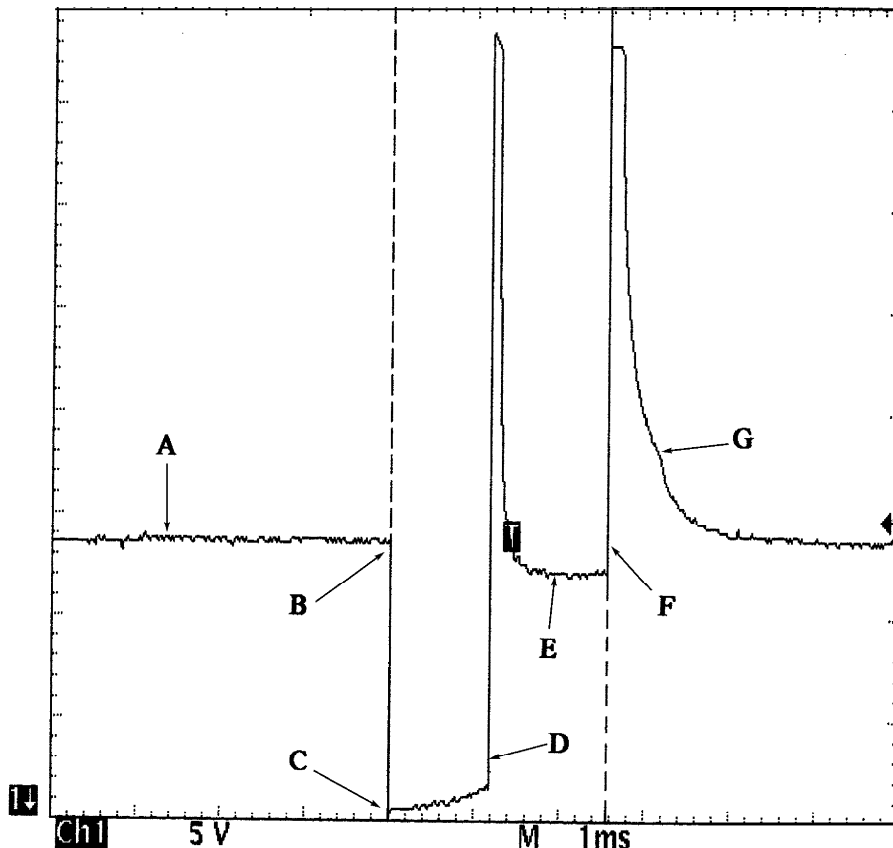


Fig. 3: Identifying Current Controlled Type Injector Pattern

## CURRENT WAVEFORM SAMPLES

### EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

The waveform pattern shown in Fig. 4 indicate a normal current waveform from a Ford 3.0L V6 VIN [U] engine. This voltage controlled type circuit pulses the injectors in groups of three injectors. Injectors No. 1, 3, and 5 are pulsed together and cylinders 2, 4, and 6 are pulsed together. The specification for an acceptable bank resistance is 4.4 ohms. Using Ohm's Law and assuming a hot run voltage of 14 volts, we determine that the bank would draw a current of 3.2 amps.

However this is not the case because as the injector windings become saturated, counter voltage is created which impedes the current flow. This, coupled with the inherent resistance of the driver's transistor, impedes the current flow even more. So, what is a known good value for a dynamic current draw on a voltage controlled bank of injectors? The waveform pattern shown below indicates a good parallel injector current flow of 2 amps. See Fig. 4.

Note that if just one injector has a resistance problem and partially shorts, the entire parallel bank that it belongs to will draw more current. This can damage the injector driver.

The waveform pattern in Fig. 5 indicates this type of problem with too much current flow. This is on other bank of injectors of the same vehicle; the even side. Notice the Lab Scope is set on a one amp per division scale. As you can see, the current is at an unacceptable 2.5 amps.

It is easy to find out which individual injector is at fault. All you need to do is inductively clamp onto each individual injector and compare them. To obtain a known-good value to compare against, we used the good bank to capture the waveform in Fig. 6. Notice that it limits current flow to 750 milliamps.

The waveform shown in Fig. 7 illustrates the problem injector we found. This waveform indicates an unacceptable current draw of just over one amp as compared to the 750 milliamper draw of the known-good injector. A subsequent check with a DVOM found 8.2 ohms, which is under the 12 ohm specification.

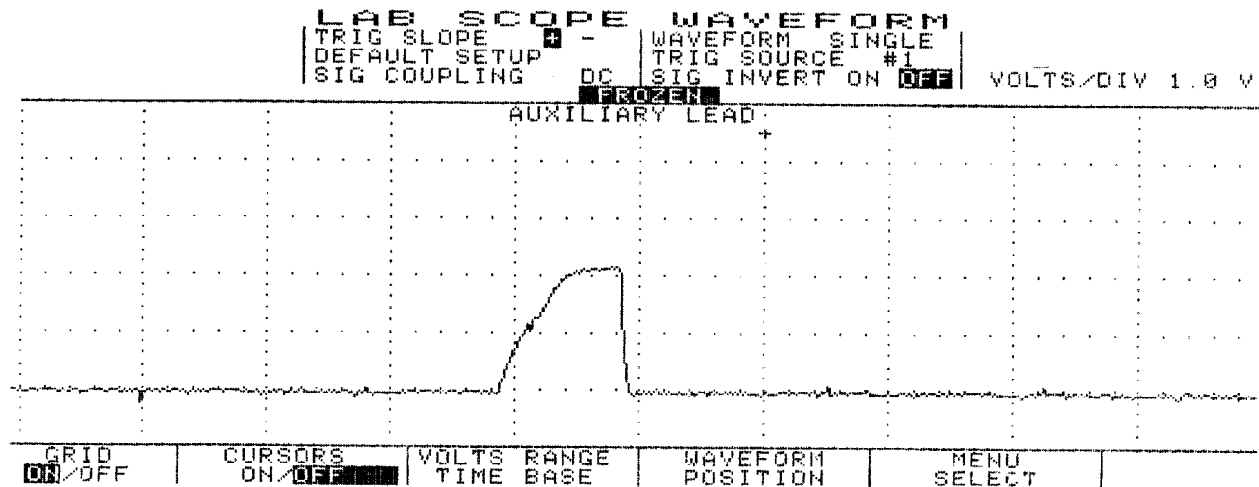
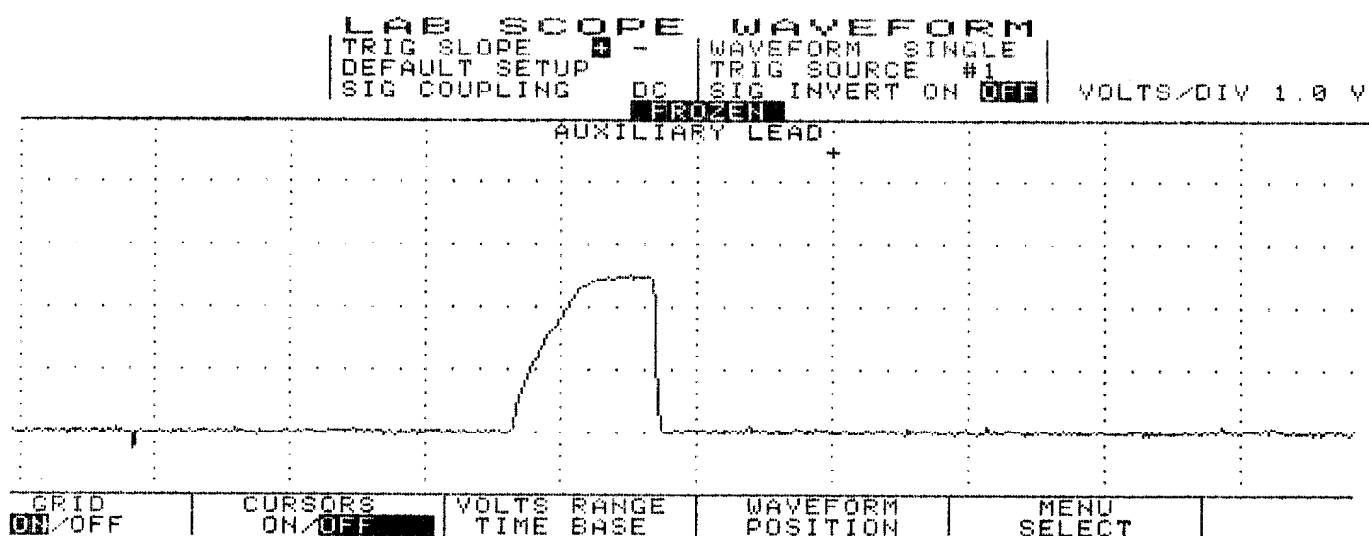
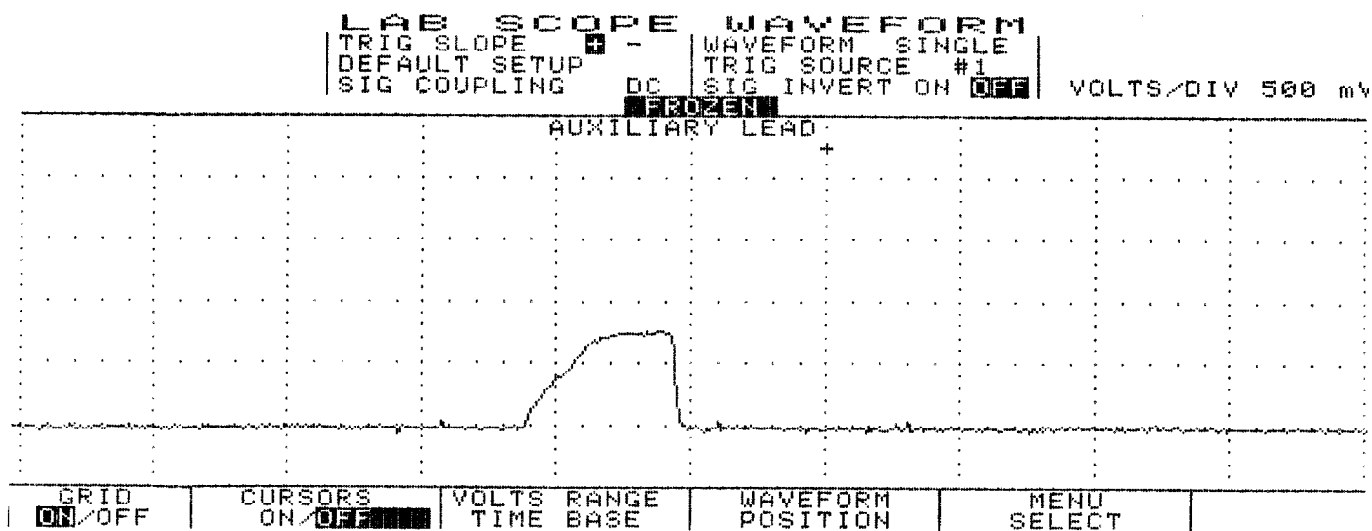


Fig. 4: Injector Bank w/Normal Current Flow - Current Pattern



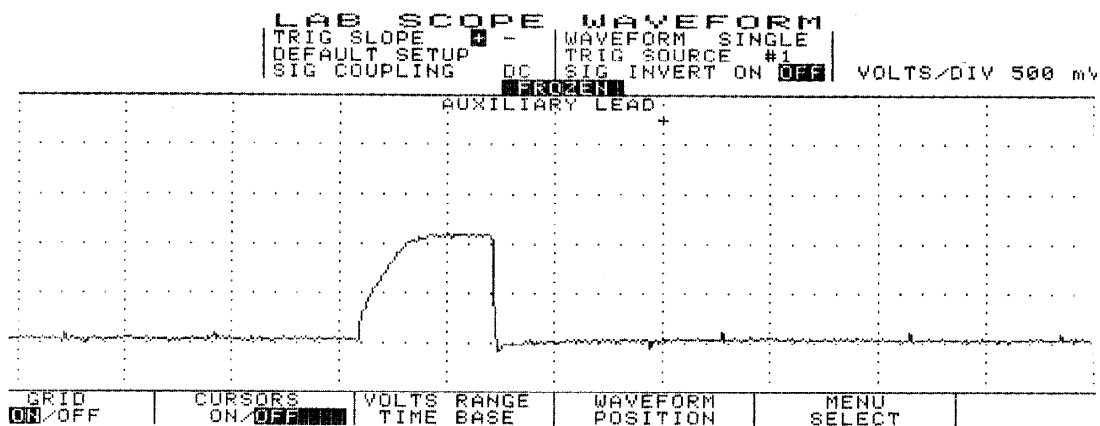
95E23865

Fig. 5: Injector Bank w/Excessive Current Flow - Current Pattern



95F23866

Fig. 6: Single Injector w/Normal Current Flow - Current Pattern



95G23867

Fig. 7: Single Injector w/Excessive Current Flow - Current Pattern

## EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

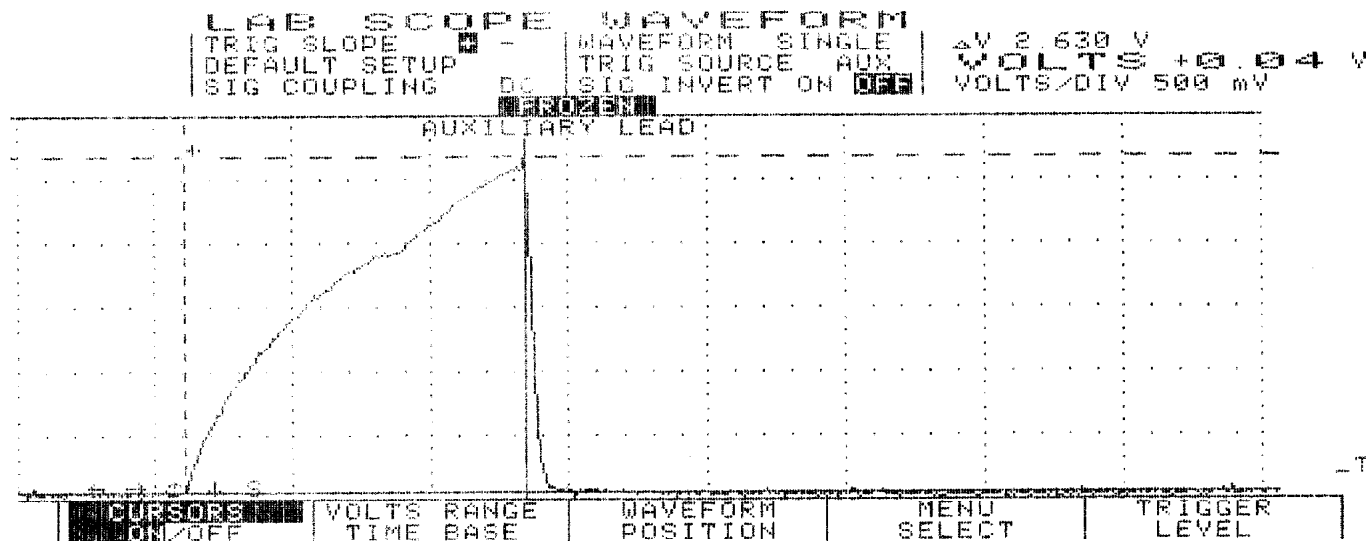
This time we will look at a GM 3.1L V6 VIN [T]. Fig. 8 shows the 1, 3, 5 (odd) injector bank with the current waveform indicating about a 2.6 amp draw at idle. This pattern, taken from a known good vehicle, correctly stays at or below the maximum 2.6 amps current range. Ideally, the current for each bank should be very close in comparison.

Notice the small dimple on the current flow's rising edge. This is the actual injector opening or what engineers refer to as the "set point." For good idle quality, the set point should be uniform between the banks.

When discussing Ohm's Law as it pertains to this parallel circuit, consider that each injector has specified resistance of 12.2 ohms. Since all three injectors are in parallel the total resistance of this parallel circuit drops to 4.1 ohms. Fourteen volts divided by four ohms would pull a maximum of 3.4 amps on this bank of injectors. However, as we discussed in EXAMPLE #1 above, other factors knock this value down to roughly the 2.6 amp neighborhood.

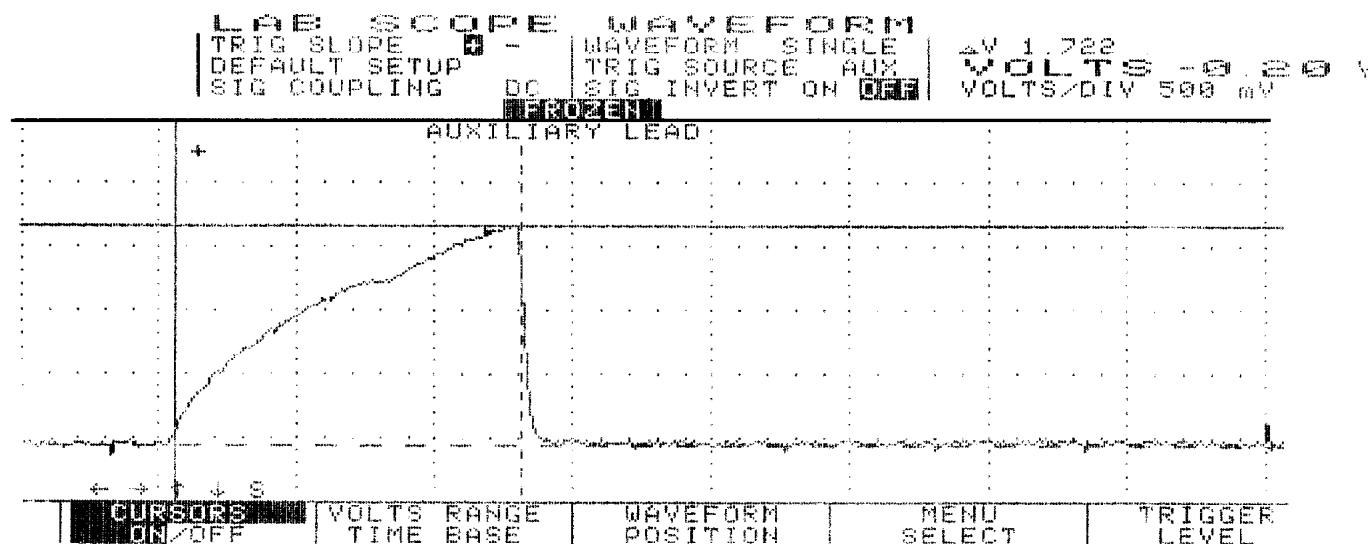
Now we are going to take a look at the even bank of injectors; injectors 2, 4, and 6. See Fig. 9. Notice this bank peaked at 1.7 amps at idle as compared to the 2.6 amps peak of the odd bank (Fig. 8). Current flow between even and odd injectors banks is not uniform, yet it is not causing a driveability problem. That is because it is still under the maximum amperage we figured out earlier. But be aware this vehicle could develop a problem if the amperage flow increases any more.

Checking the resistance of this even injector group with a DVOM yielded 6.2 ohms, while the odd injector group in the previous example read 4.1 ohms.



95E23873

Fig. 8: Injector Odd Bank w/Normal Current Flow - Current Pattern



95F23874

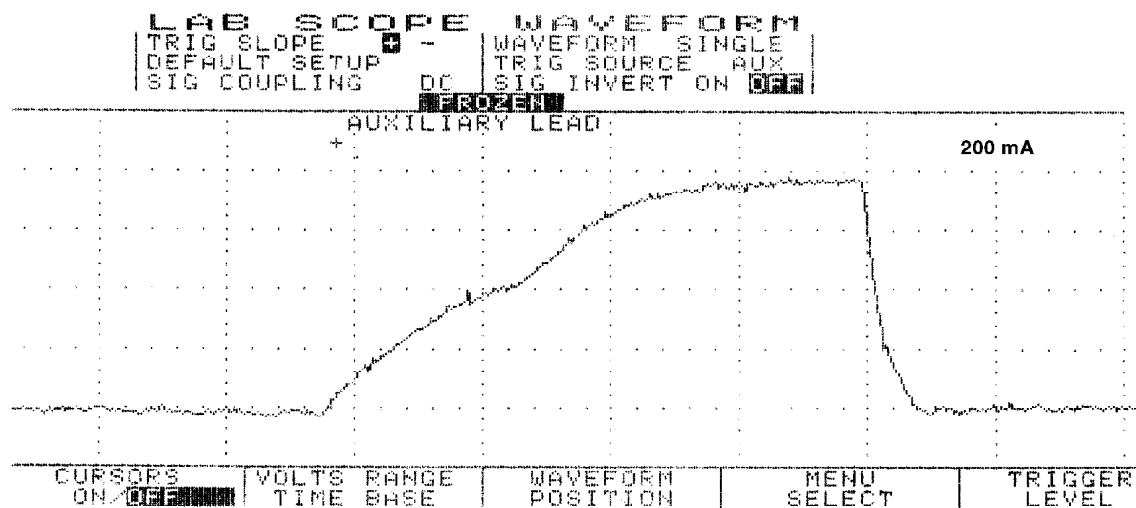
Fig. 9: Injector Even Bank w/Normal Current Flow - Current Pattern

### EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

Example #3 is of a Ford 5.0L V8 SEFI. Fig. 10 shows a waveform of an individual injector at idle with the Lab Scope set on 200 milliamps per division. Notice the dimple in the rising edge. This dimple indicates the actual opening of the injector (set point) occurred at 400 milliamps and current peaked at 750 milliamps. This is a good specification for this engine.

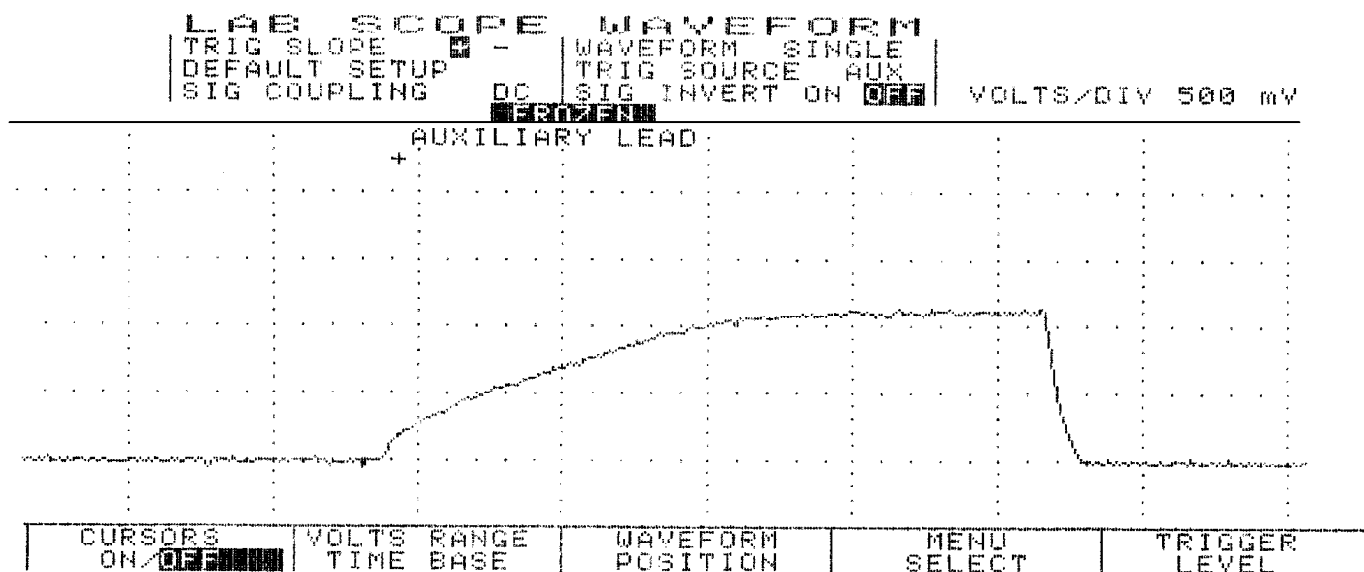
The next waveform pattern in Fig. 11 shows an abnormality with another injector. With the Lab Scope set on 500 milliamps per division, you can see that the current waveform indicates a 1200 milliamp draw. This is a faulty injector.

Abnormally low resistance injectors create excessive current draw, causing rough idle, and possible computer driver damage.



95G23875

Fig. 10: Single Injector w/Normal Current Flow - Current Pattern



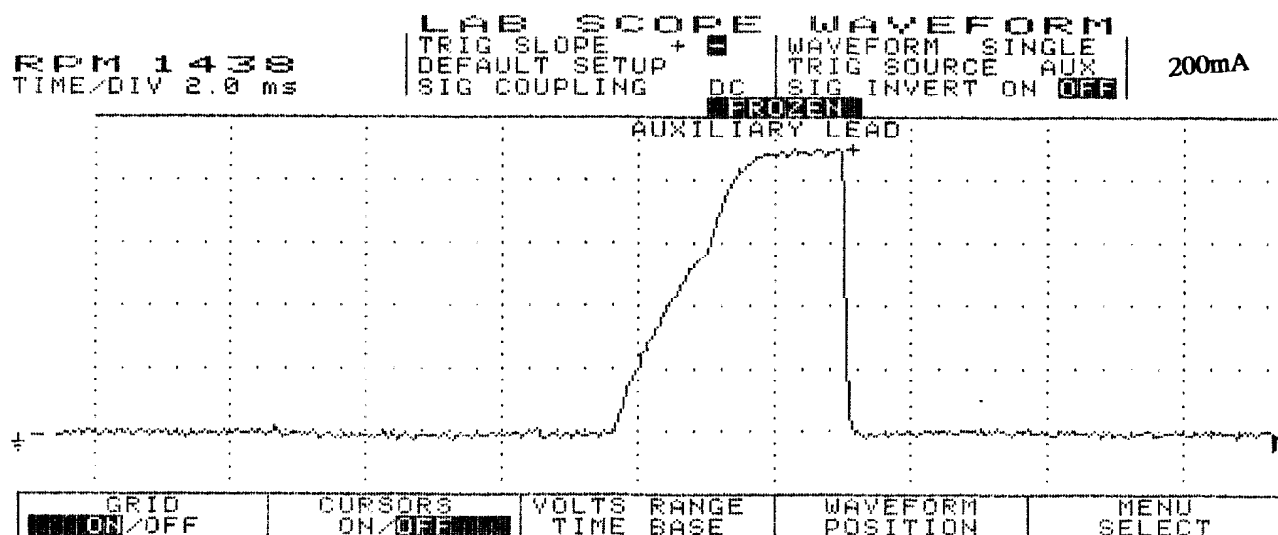
95H23876

Fig. 11: Single Injector w/Excessive Current Flow - Current Pattern

#### EXAMPLE #4 - CURRENT CONTROLLED DRIVER

Example #4 is of a Ford 4.6L SEFI VIN [W]. See Fig. 12 for the known-good waveform pattern. This Ford system is different from the one above in EXAMPLE #3 as it peaks at 900 milliamps and the actual opening of the injector (set point) is just below 600 milliamps.

This is offered as a comparison against the Ford pattern listed above, as they are both Ford SEFI injectors but with different operating ranges. The point is that you should not make any broad assumptions for any manufacturer.



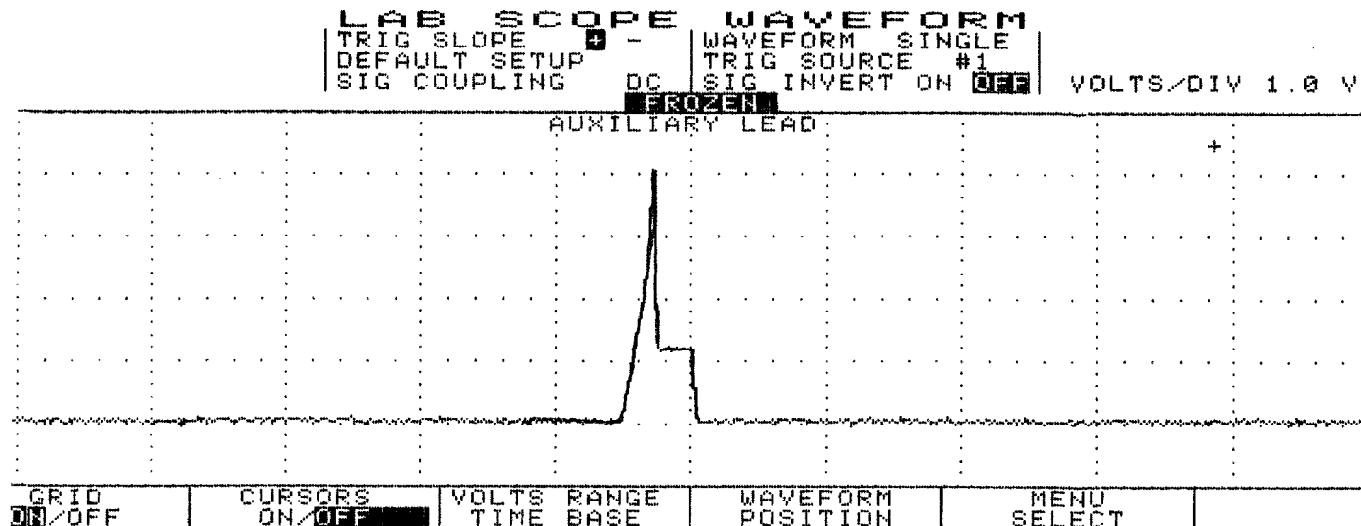
95D23872

Fig. 12: Single Injector w/Normal Current Flow - Current Pattern

#### EXAMPLE #5 - CURRENT CONTROLLED DRIVER

The known-good waveform in Fig. 13 is from a Chrysler 3.0L V6

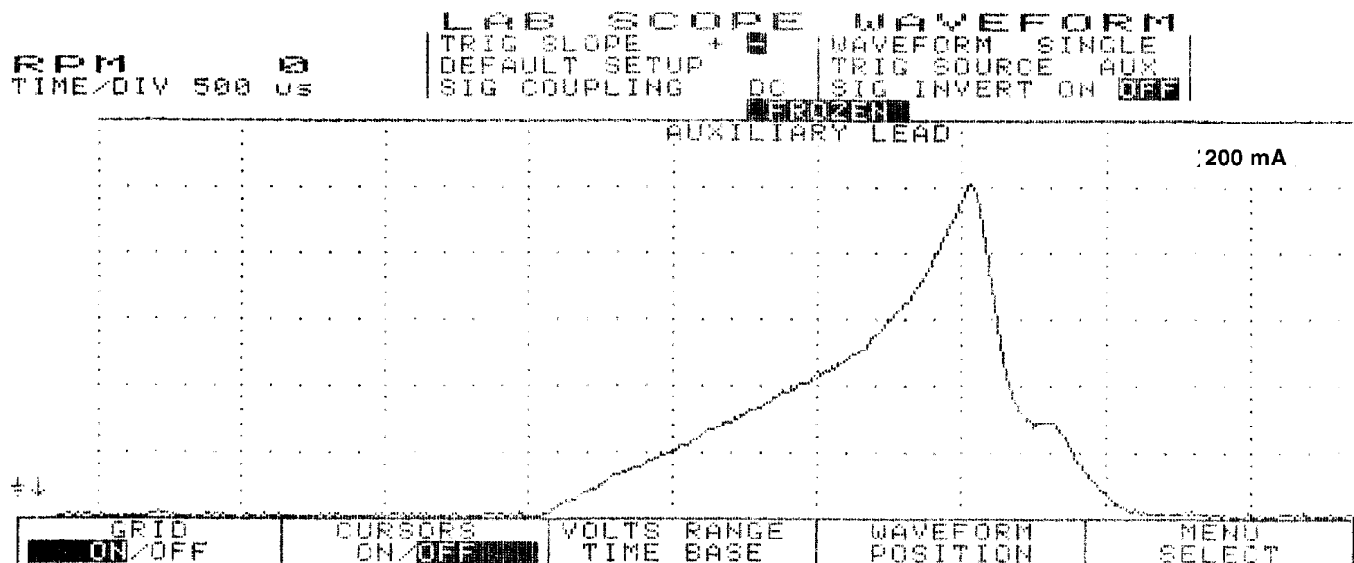
PFI VIN [3]. It is a perfect example of the peak and hold theory. The waveform shows a 1-amp per division current flow, ramping to 4 amps and then decreasing to 1-amp to hold the injector open.



95H23868  
Fig. 13: Injector Bank w/Normal Current Flow - Current Pattern

### EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This next known-good waveform is from a Ford 5.0L V8 CFI VIN [F]. See Fig. 14. The pattern, which is set on a 250 milliamps scale, indicates a 1.25 amp peak draw and a hold at 350 milliamps.



95I23869  
Fig. 14: Single Injector w/Normal Current Flow - Current Pattern

### EXAMPLE #7 - CURRENT CONTROLLED DRIVER

The known-good current controlled type waveform in Fig. 15 is from a GM 2.0L TBI VIN [1]. With the lab scope set at 2 amps per division, notice that this system peaks at 4 amps and holds at 1 amp. The next waveform is from the same type of engine, except



LAB SCOPE WAVEFORM

RPM 5721  
TIME/DIV 1.0 ms

TRIG SLOPE  $\uparrow$  -  
DEFAULT SETUP  
SIG COUPLING DC

WAVEFORM SINGLE  
TRIG SOURCE #1  
SIG INVERT ON OFF

2 AMPS

FROZEN

AUXILIARY LEAD

GRID ON/OFF  
CURSORS ON/OFF  
VOLTS RANGE  
TIME BASE  
WAVEFORM POSITION  
MENU SELECT

```

LAB SCOPE WAVEFORM
TRIG SLOPE  $\Delta$  - WAVEFORM SINGLE
DEFAULT SETUP TRIG SOURCE AUX
SIG COUPLING DC SIG INVERT ON OFF VOLTS/DIV 1.0 V
FROZEN
AUXILIARY LEAD
+

```

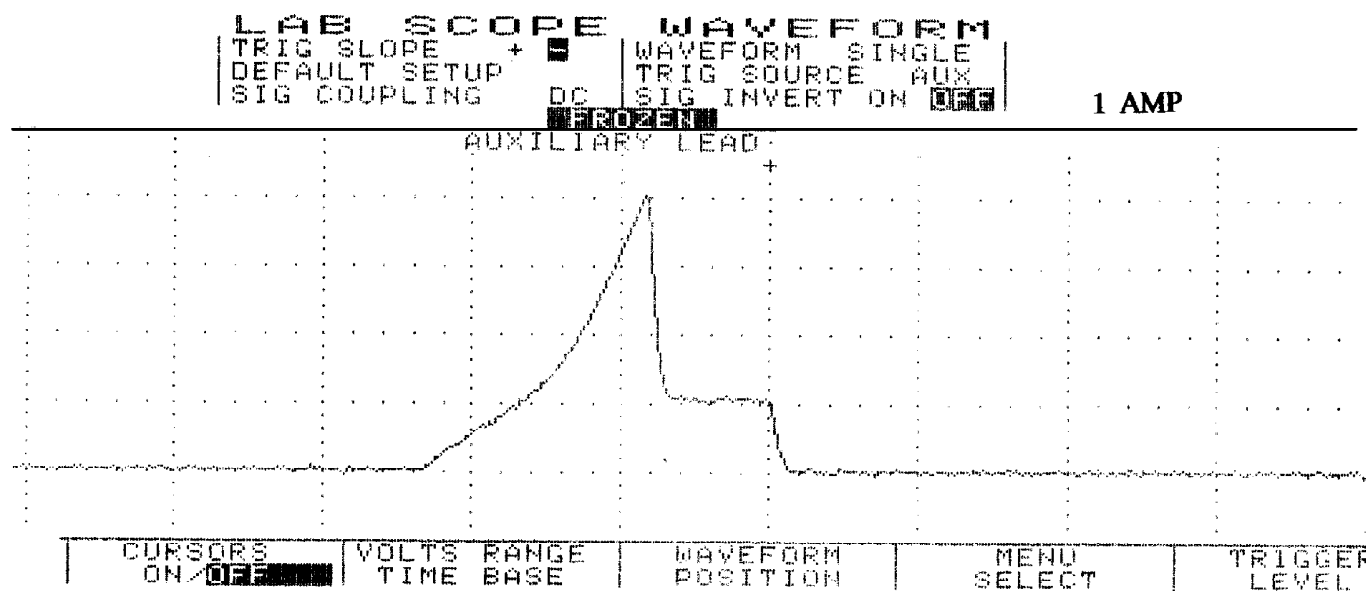
```

CURSORS ON/OFF VOLTS RANGE WAVEFORM MENU TRIGGER
ON/OFF TIME BASE POSITION SELECT LEVEL

```

### EXAMPLE #8 - CURRENT CONTROLLED DRIVER

This known-good CPI system waveform from a GM 4.3L V6 CPI VIN [W] peaks at 4 amps and holds at 1-amp. See Fig. 17 for waveform.



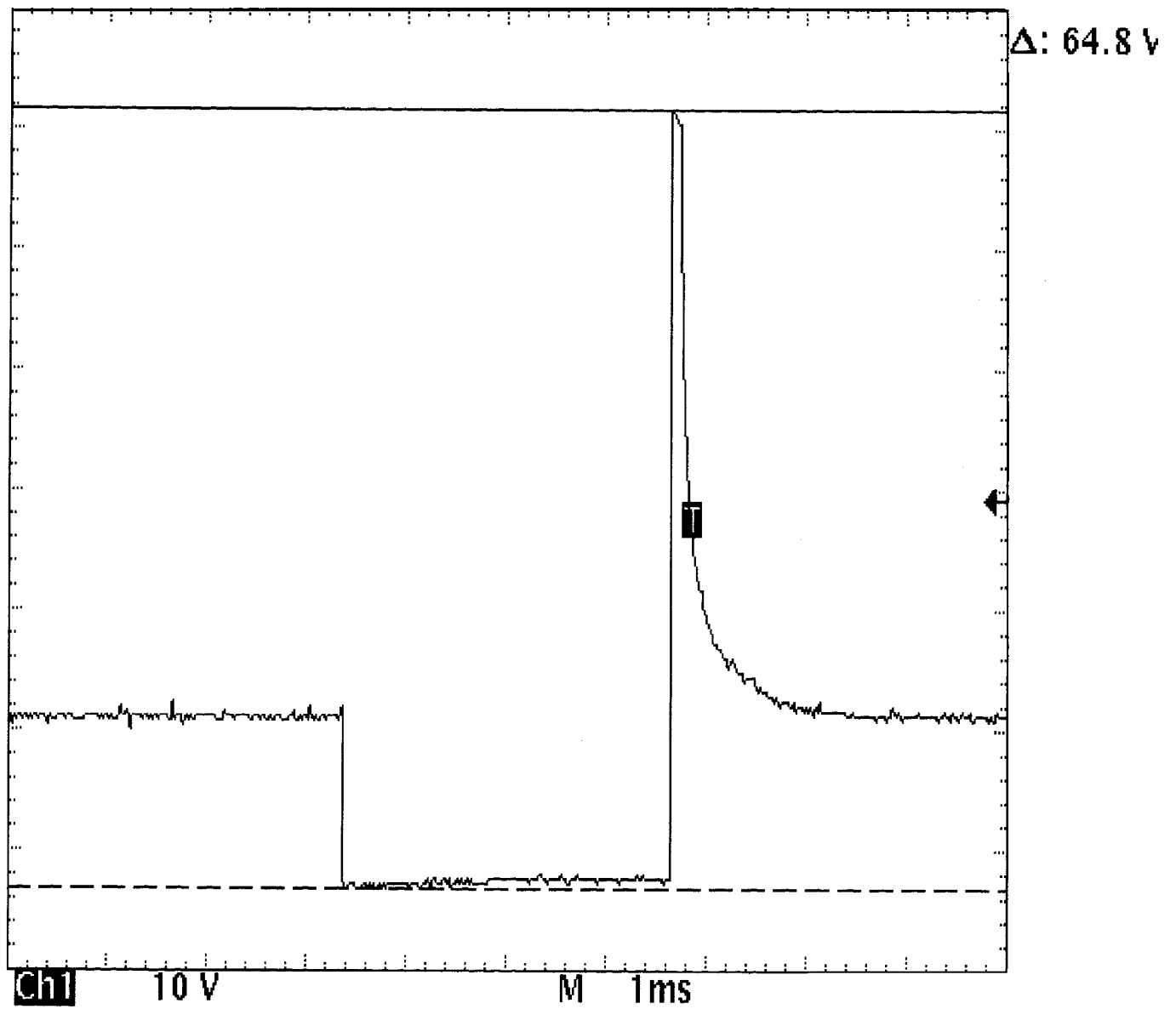
95B23870

Fig. 17: Single Injector w/Normal Current Flow - Current Pattern

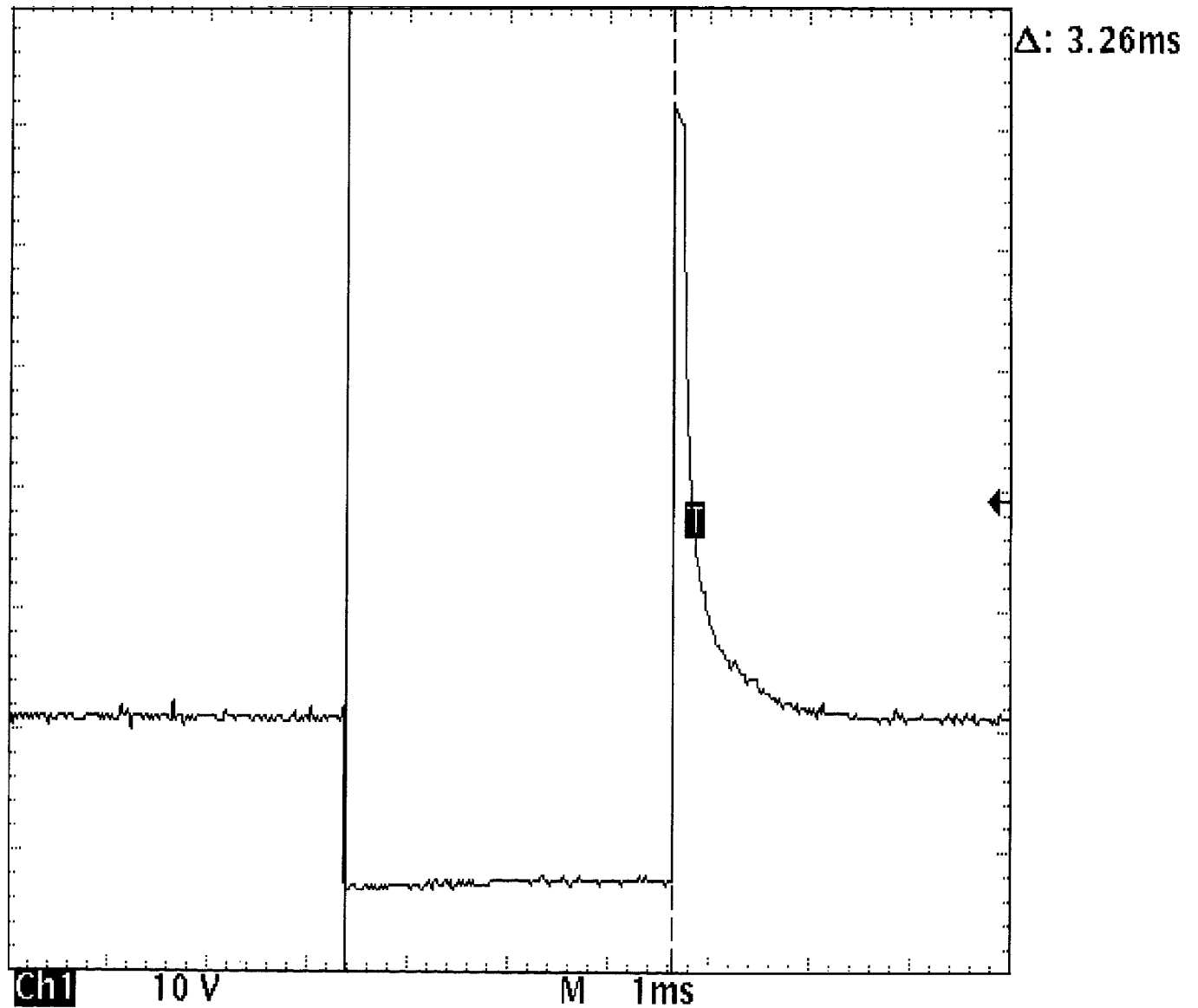
## VOLTAGE WAVEFORM SAMPLES

### EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

These two known-good waveform patterns are from a Ford 4.6L V8 VIN [W]. Fig. 18 illustrates the 64 volt inductive kick on this engine, indicating no clamping is occurring. The second pattern, Fig. 19, was taken during hot idle, closed loop, and no load.



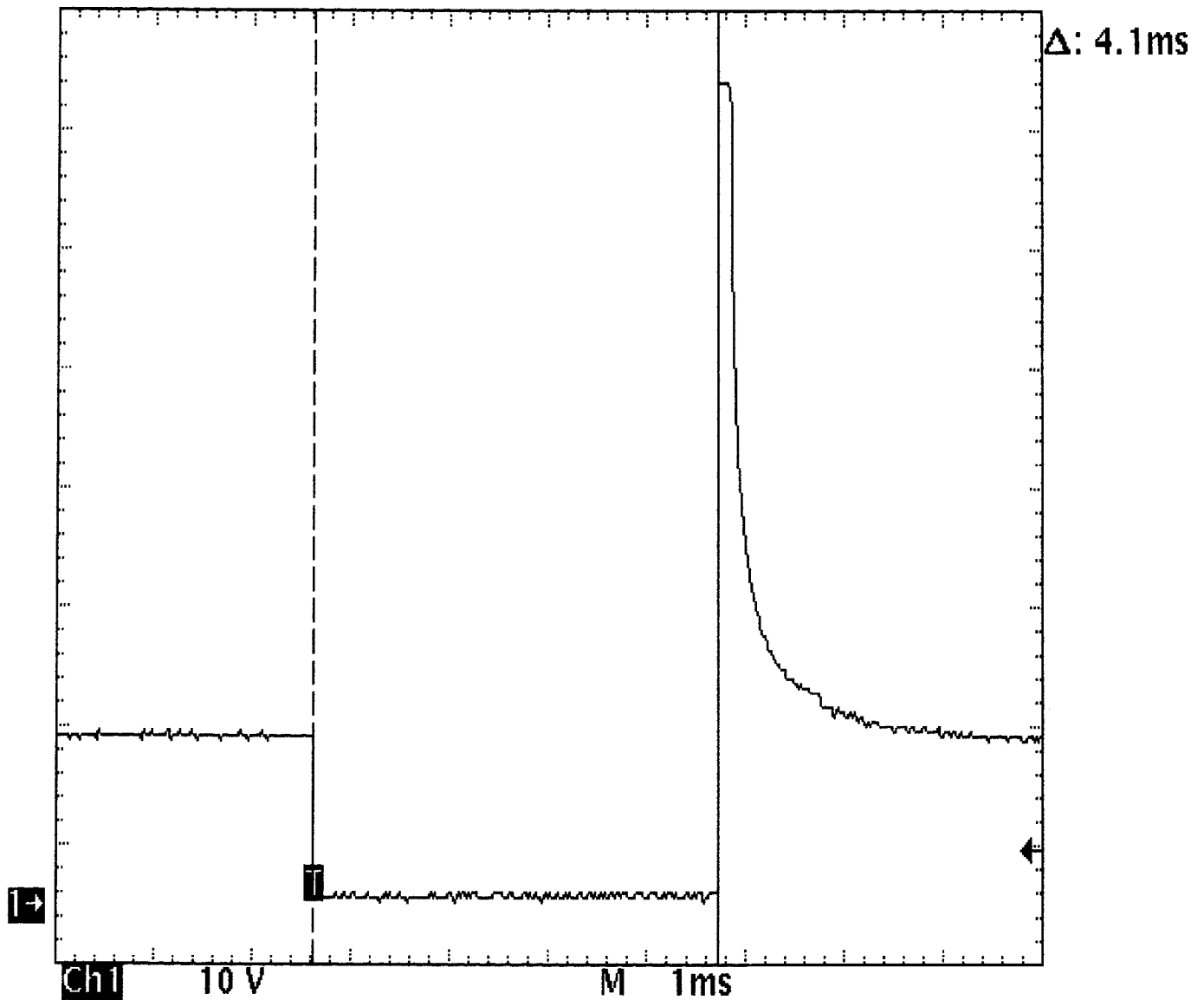
95E23857  
Fig. 18: Injector Bank - Known Good - Voltage Pattern



95F23858  
Fig. 19: Injector Bank - Known Good - Voltage Pattern

#### EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

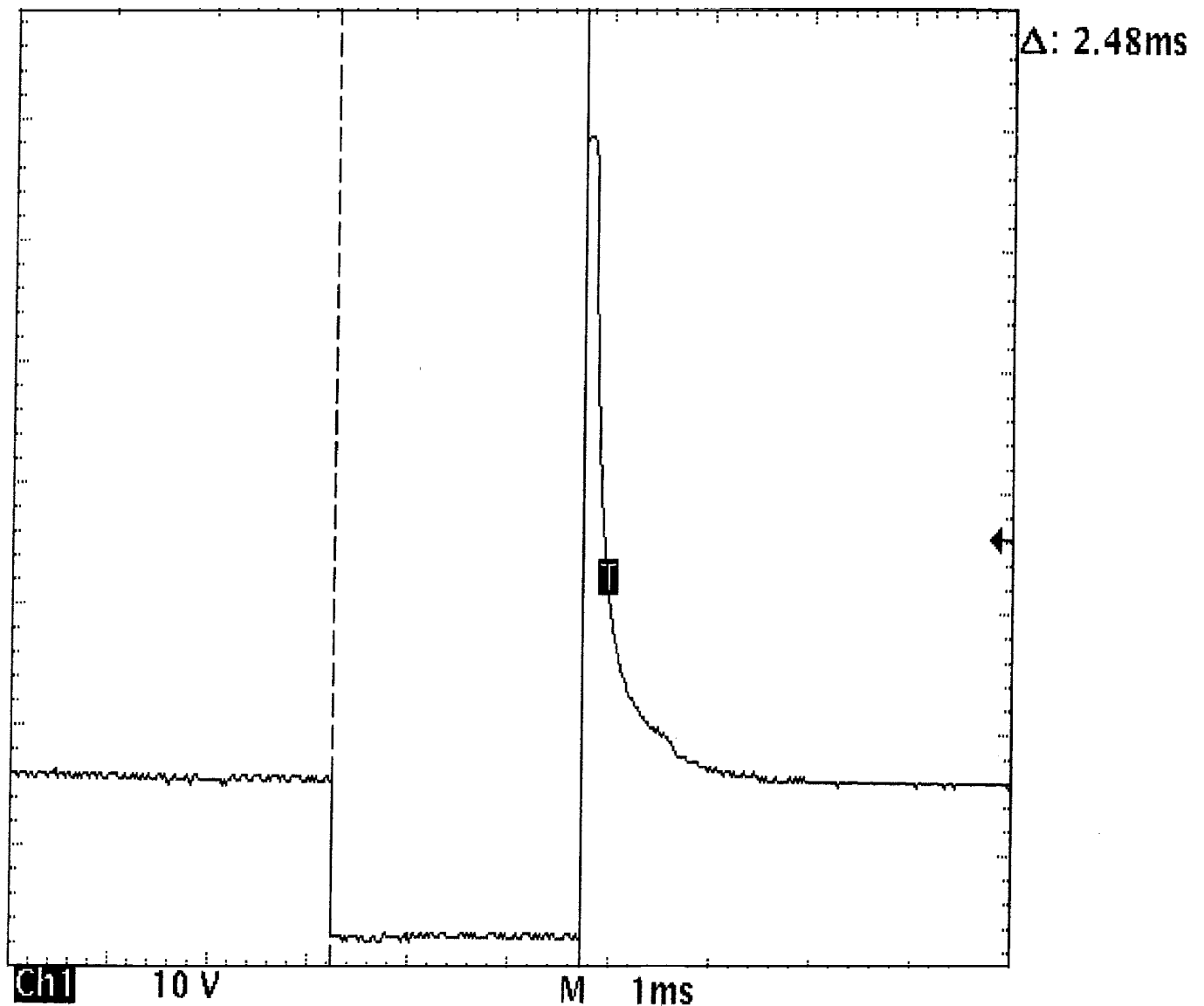
The known-good waveform pattern in Fig. 20 is from a GM 3.8L V6 PFI VIN [3]. It was taken during hot idle, closed loop and no load.



95123851  
Fig. 20: Injector Bank - Known Good - Voltage Pattern

### EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

This known-good waveform pattern, Fig. 21, is from a GM 5.0L V8 TPI VIN [F]. It was taken during hot idle, closed loop and no load.

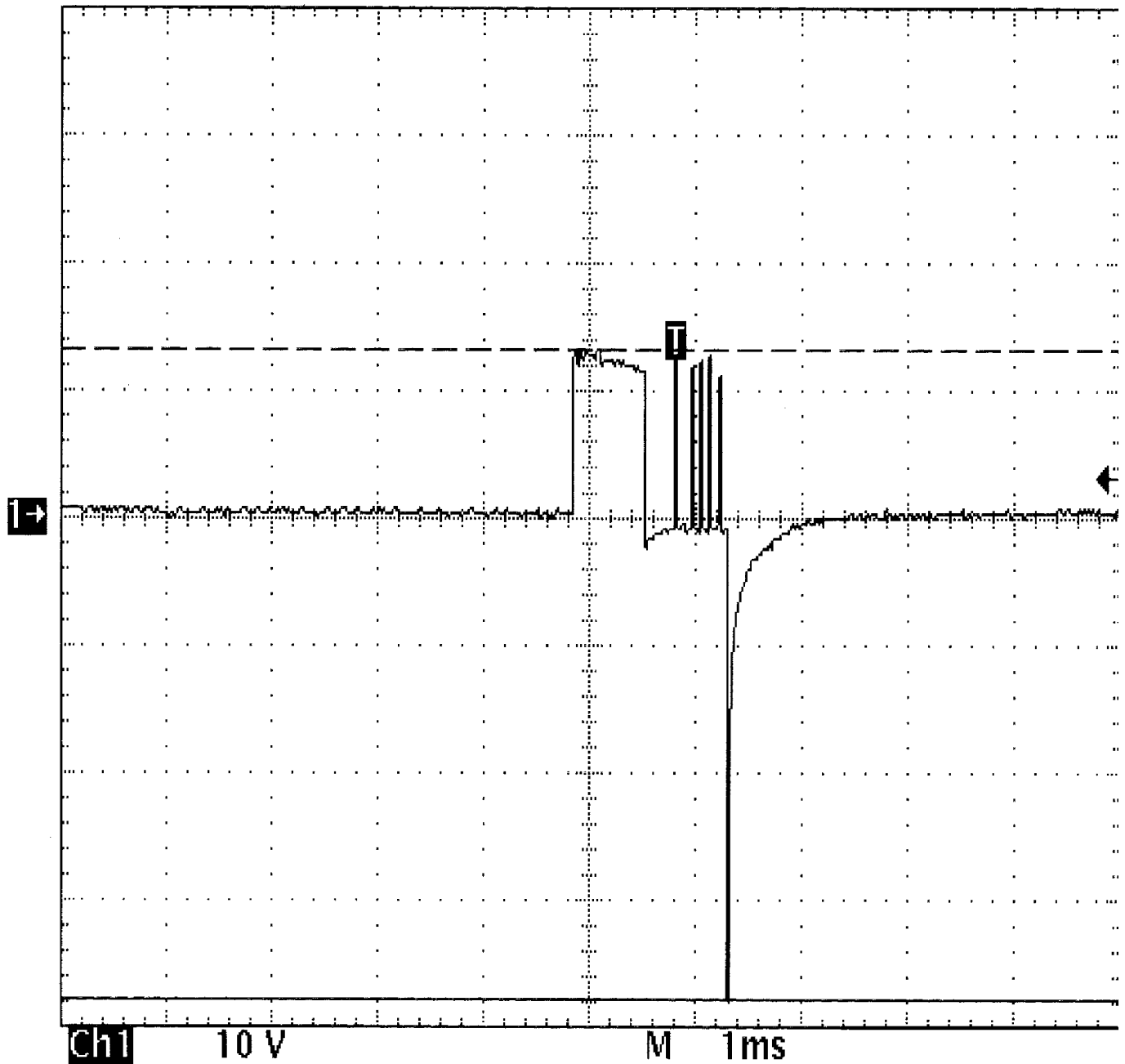


95G23859  
Fig. 21: Injector Bank - Known Good - Voltage Pattern

#### EXAMPLE #4 - CURRENT CONTROLLED DRIVER

From 1984 to 1987, Chrysler used this type injector drive on their TBI-equipped engines. See Fig. 22 for a known-good pattern. Instead of the ground side controlling the injector, Chrysler permanently grounds out the injector and switches the power feed side. Most systems do not work this way.

These injectors peak at 6 amps of current flow and hold at 1 amp.



95J23860  
Fig. 22: Single Injector - Known Good - Voltage Pattern

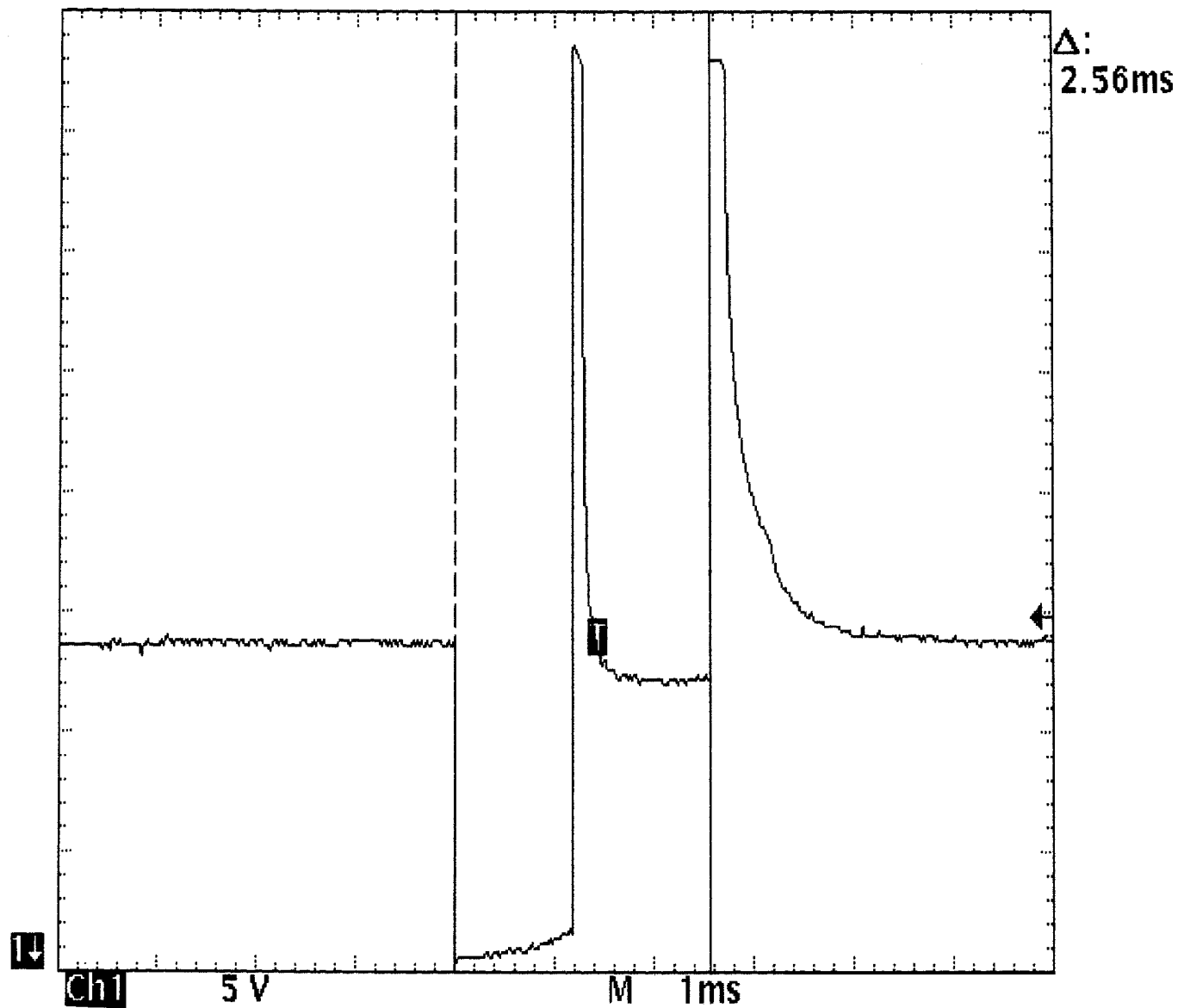
#### EXAMPLE #5 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a Chrysler 3.0L V6 VIN [3]. The first waveform, Fig. 23, is a dual trace pattern that illustrates how Chrysler uses the rising edge of the engine speed signal to trigger the injectors. The second waveform, Fig. 24, was taken during hot idle, closed loop, and no load.



Fig. 23: Injector Bank - Known Good - Voltage Pattern

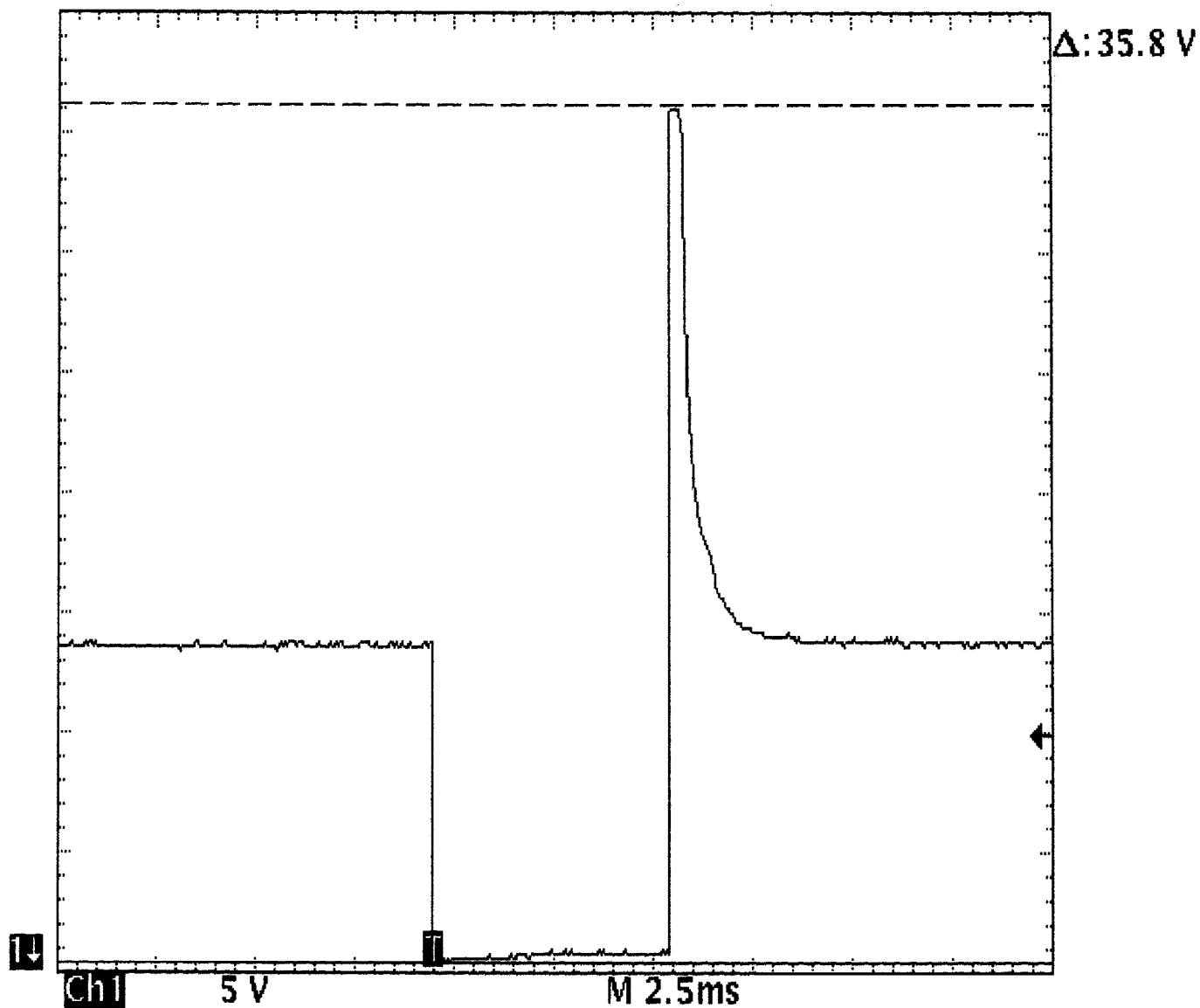




95B23854  
Fig. 24: Injector Bank - Known Good - Voltage Pattern

#### EXAMPLE #6 - CURRENT CONTROLLED DRIVER

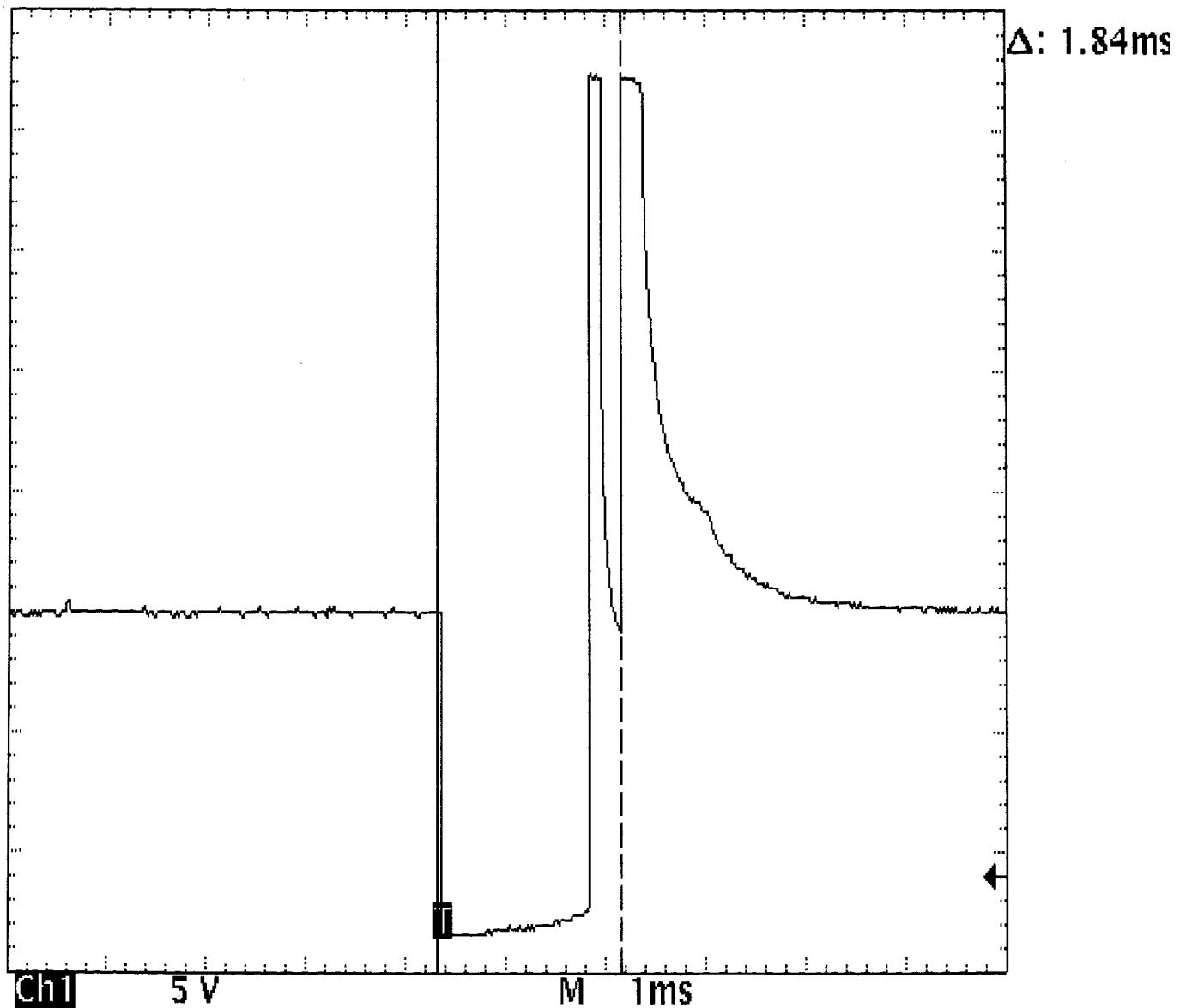
This known-good pattern from a Ford 3.0L V6 PFI VIN [U] illustrates that a zener diode inside the computer is used to clamp the injector's inductive kick to 35-volts on this system. See Fig. 25.



95J23852  
Fig. 25: Injector Bank - Known Good - Voltage Pattern

#### EXAMPLE #7 - CURRENT CONTROLLED DRIVER

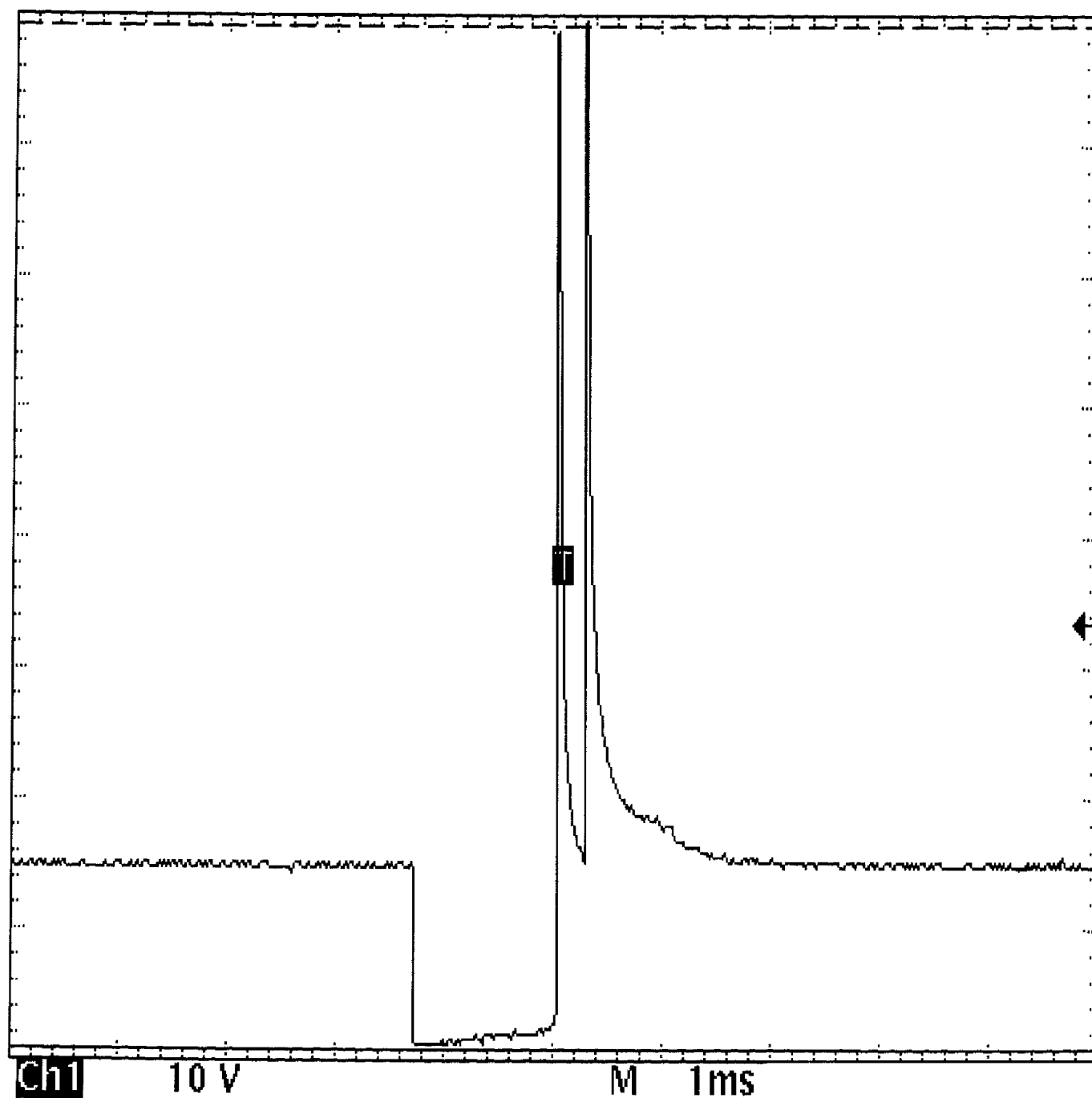
This known-good waveform from a Ford 5.0L V8 CFI VIN [F] was taken during hot idle, closed loop, and no load. See Fig. 26.



95D23856  
Fig. 26: Single Injector - Known Good - Voltage Pattern

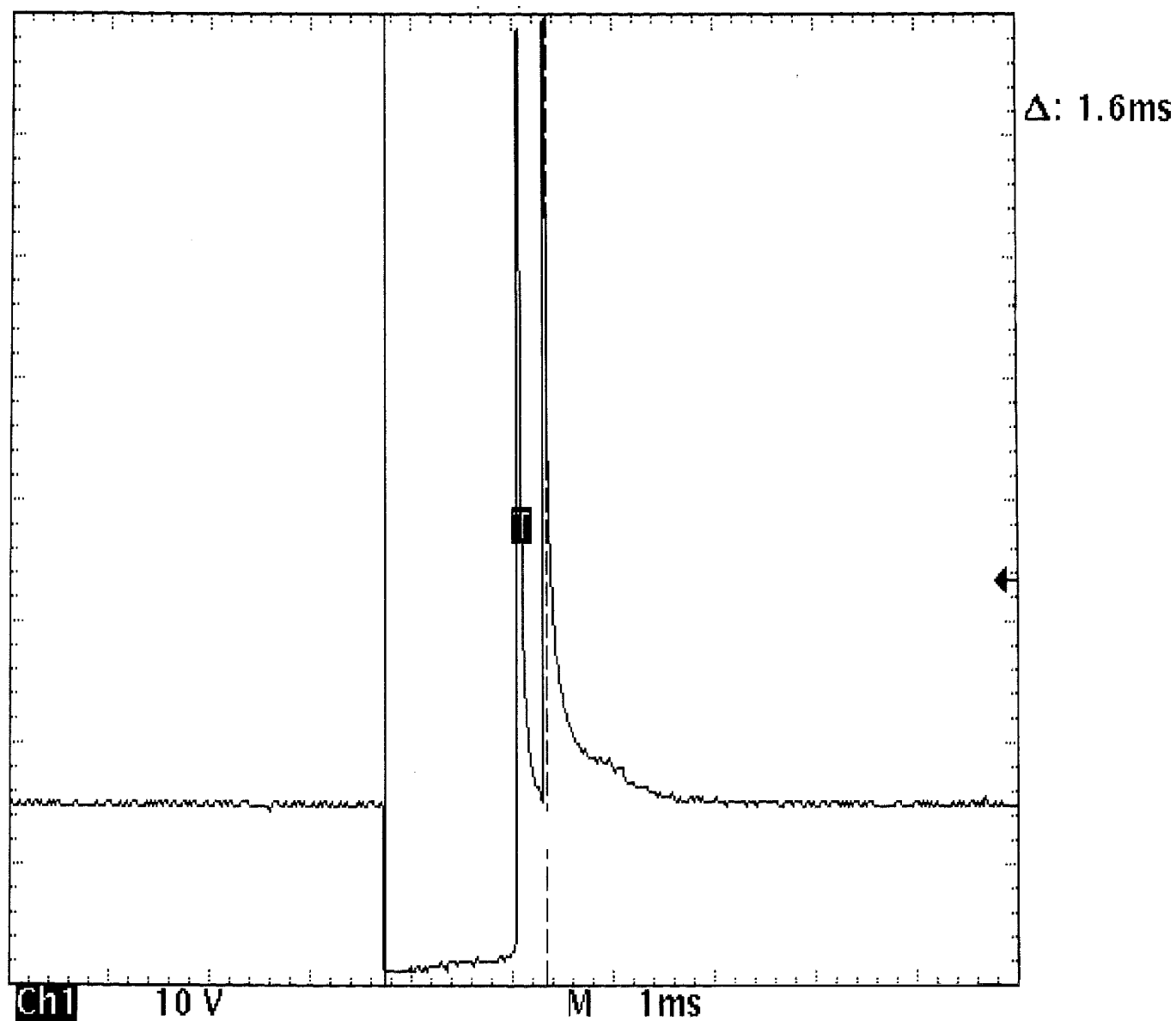
#### EXAMPLE #8 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a GM 2.0L In-Line 4 VIN [1]. Fig. 27 illustrates the 78 volt inductive spike that indicates a zener diode is not used. The second waveform, Fig. 28, was taken during hot idle, closed loop, and no load.



95D23849

Fig. 27: Single Injector - Known Good - Voltage Pattern



95H23850  
Fig. 28: Single Injector - Known Good - Voltage Pattern

# WHEEL ALIGNMENT THEORY/OPERATION

1993 Jeep Cherokee

## GENERAL INFORMATION

Wheel Alignment Theory & Operation

ALL MODELS

### \* PLEASE READ THIS FIRST \*

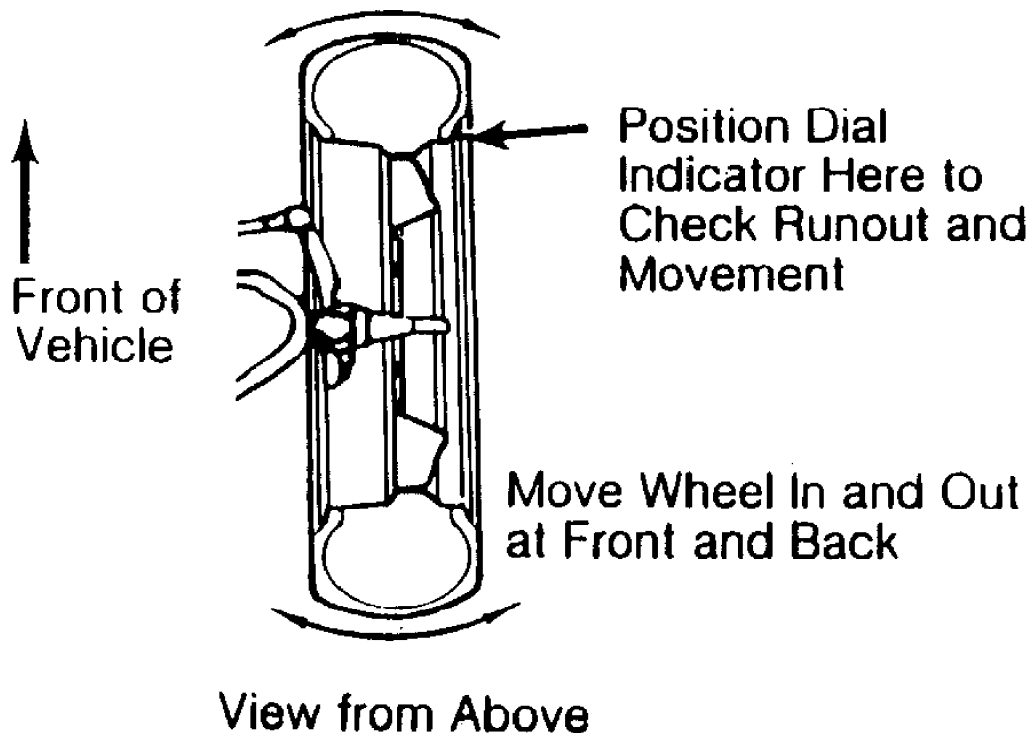
NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models.

## PRE-ALIGNMENT INSTRUCTIONS

### GENERAL ALIGNMENT CHECKS

Before adjusting wheel alignment, check the following:

- \* Each axle uses tires of same construction and tread style, equal in tread wear and overall diameter. Verify that radial and axial runout is not excessive. Inflation should be at manufacturer's specifications.
- \* Steering linkage and suspension must not have excessive play. Check for wear in tie rod ends and ball joints. Springs must not be sagging. Control arm and strut rod bushings must not have excessive play. See Fig. 1.



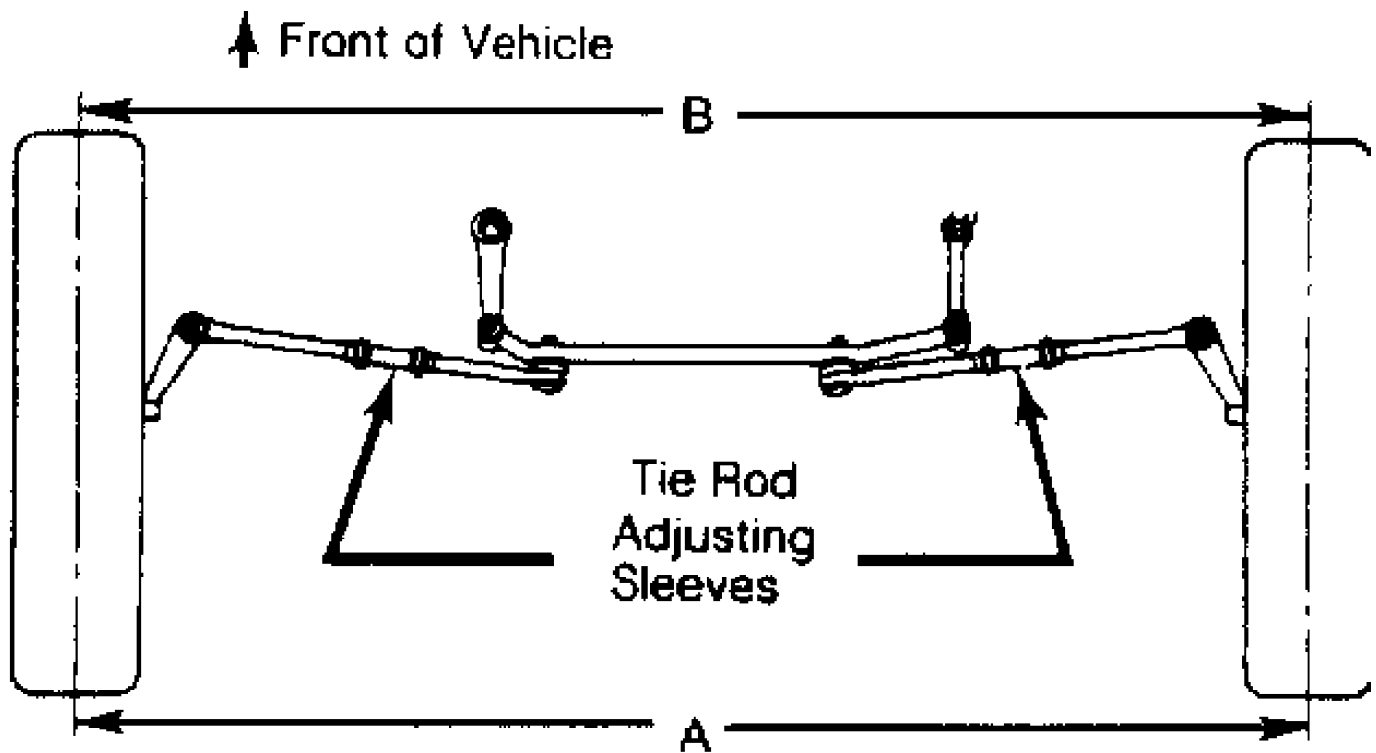
26694

Fig. 1: Checking Steering Linkage

- \* Vehicle must be on level floor with full fuel tank, no passenger load, spare tire in place and no load in trunk. Bounce front and rear end of vehicle several times. Confirm

- vehicle is at normal riding height.
- \* Steering wheel must be centered with wheels in straight ahead position. If required, shorten one tie rod adjusting sleeve and lengthen opposite sleeve (equal amount of turns). See Fig. 2.
  - \* Wheel bearings should have the correct preload and lug nuts must be tightened to manufacturer's specifications. Adjust camber, caster and toe-in using this sequence. Follow instructions of the alignment equipment manufacturer.

**CAUTION:** Do not attempt to correct alignment by straightening parts. Damaged parts must be replaced.



**26695**

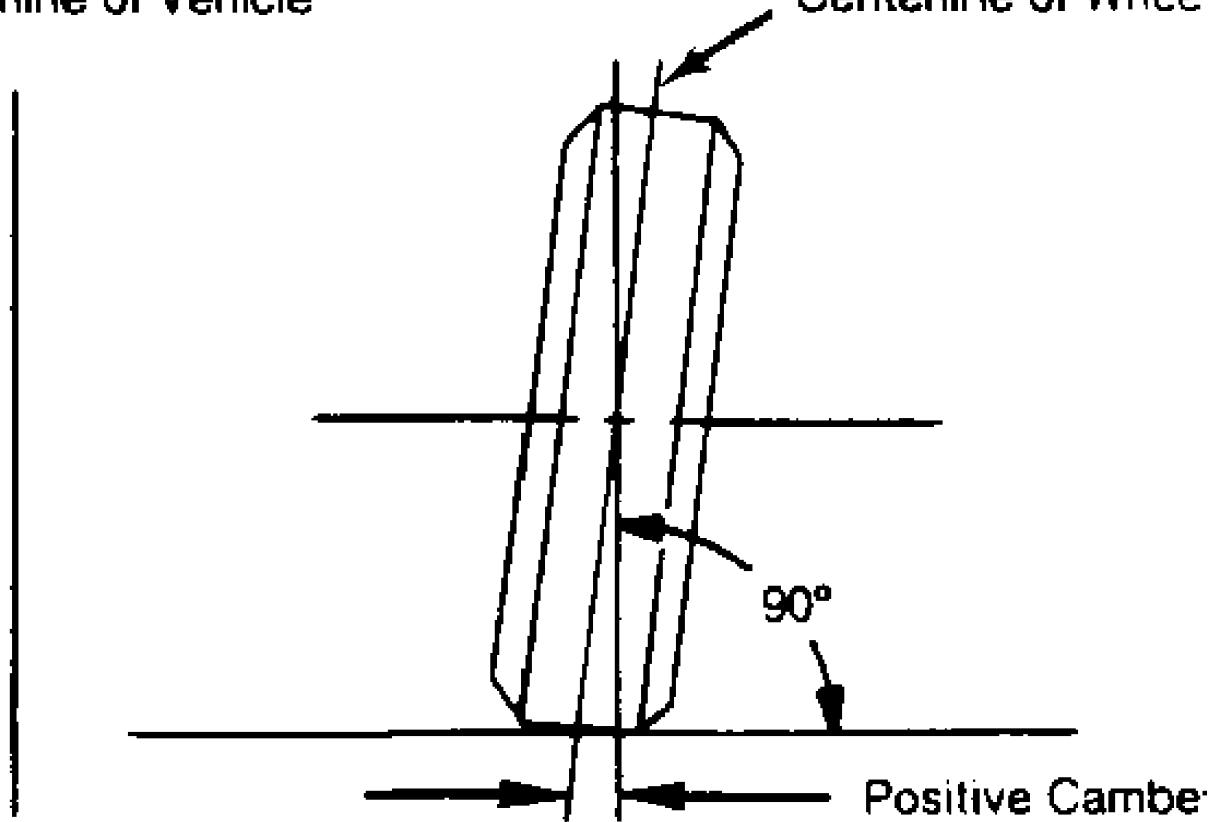
Fig. 2: Adjusting Tie Rod Sleeves (Top View)

### CAMBER

- 1) Camber is the tilting of the wheel, outward at either top or bottom, as viewed from front of vehicle. See Fig. 3.
- 2) When wheels tilt outward at the top (from centerline of vehicle), camber is positive. When wheels tilt inward at top, camber is negative. Amount of tilt is measured in degrees from vertical.

Centerline of Vehicle

Centerline of Wheel



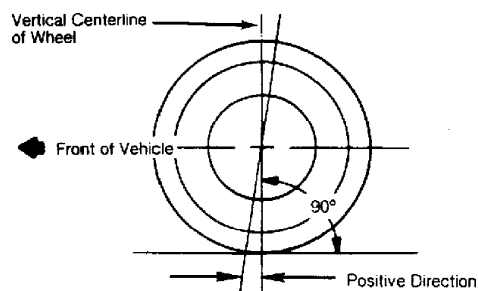
26696

Fig. 3: Determining Camber Angle

## CASTER

1) Caster is tilting of front steering axis either forward or backward from vertical, as viewed from side of vehicle. See Fig. 4.

2) When axis is tilted backward from vertical, caster is positive. This creates a trailing action on front wheels. When axis is tilted forward, caster is negative, causing a leading action on front wheels.



26697

Fig. 4: Determining Caster Angle

## TOE-IN ADJUSTMENT

Toe-in is the width measured at the rear of the tires

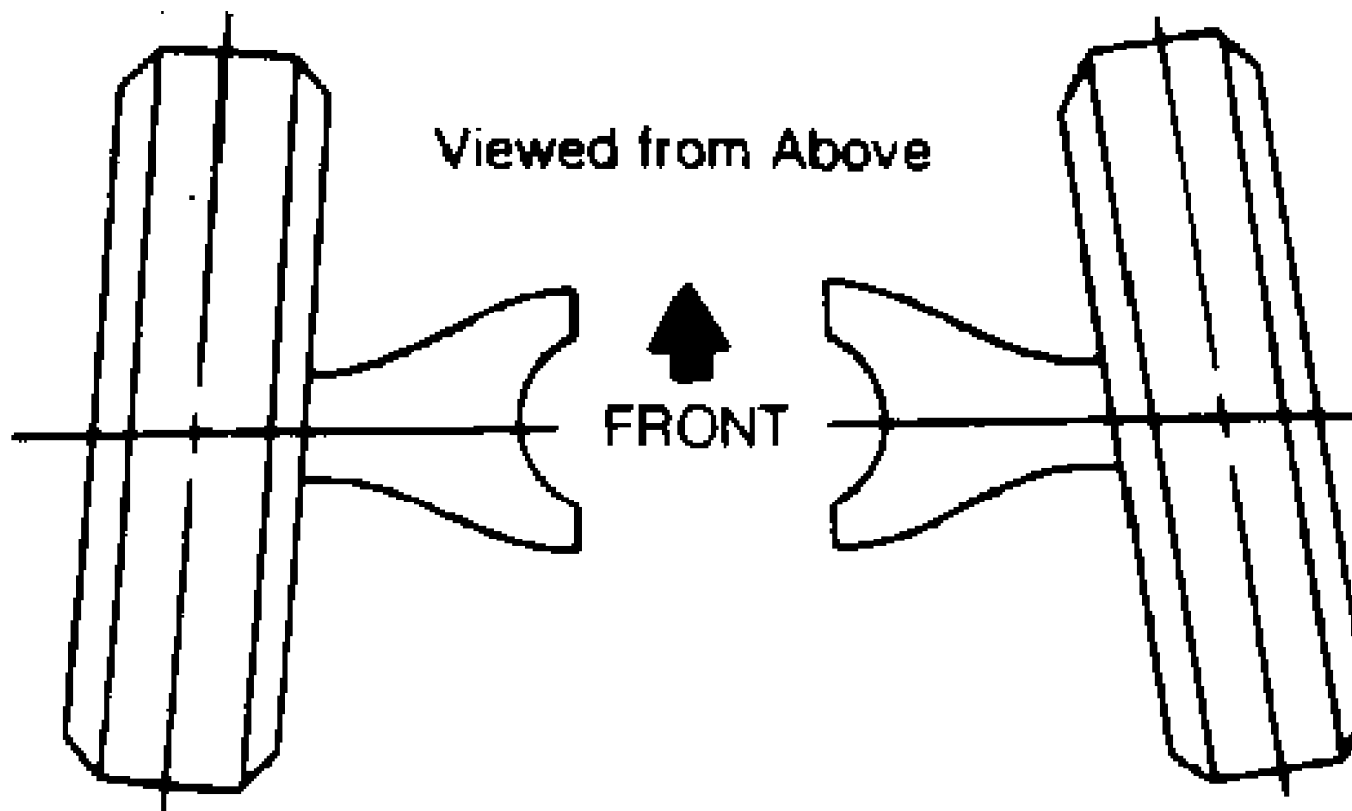


subtracted by the width measured at the front of the tires at about spindle height. A positive figure would indicate toe-in and a negative figure would indicate toe-out. If the distance between the front and rear of the tires is the same, toe measurement would be zero. To adjust:

1) Measure toe-in with front wheels in straight ahead position and steering wheel centered. To adjust toe-in, loosen clamps and turn adjusting sleeve or adjustable end on right and left tie rods. See Figs. 2 and 5.

2) Turn equally and in opposite directions to maintain steering wheel in centered position. Face of tie rod end must be parallel with machined surface of steering rod end to prevent binding.

3) When tightening clamps, make certain that clamp bolts are positioned so there will be no interference with other parts throughout the entire travel of linkage.



**26698**

Fig. 5: Wheel Toe-In (Dimension A Less Dimension B)

### TOE-OUT ON TURNS

1) Toe-out on turns (turning radius) is a check for bent or damaged parts, and not a service adjustment. With caster, camber, and toe-in properly adjusted, check toe-out with weight of vehicle on wheels.

2) Use a full floating turntable under each wheel, repeating test with each wheel positioned for right and left turns. Incorrect toe-out generally indicates a bent steering arm. Replace arm, if necessary, and recheck wheel alignment.

## STEERING AXIS INCLINATION

1) Steering axis inclination is a check for bent or damaged parts, and not a service adjustment. Vehicle must be level and camber should be properly adjusted. See Fig. 6.

2) If camber cannot be brought within limits and steering axis inclination is correct, steering knuckle is bent. If camber and steering axis inclination are both incorrect by approximately the same amount, the upper and lower control arms are bent.

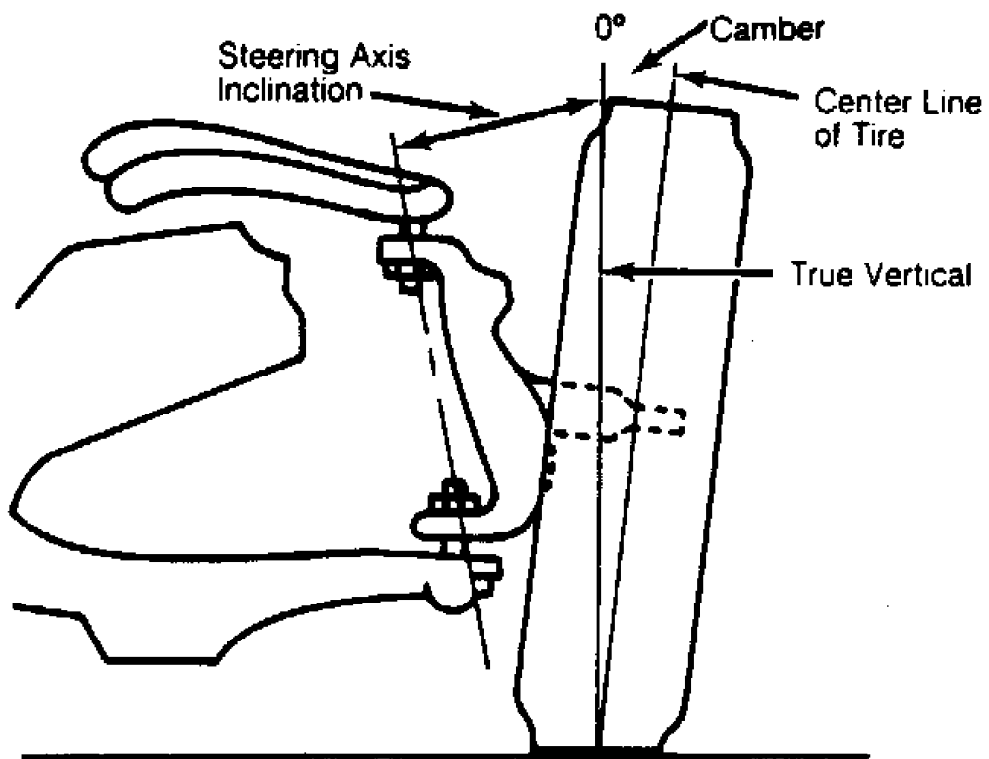


Fig. 6: Checking Steering Axis Inclination

# WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

1993 Jeep Cherokee

1993 WHEEL ALIGNMENT  
Chrysler Corp. Specifications & Procedures

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

## WHEEL ALIGNMENT PROCEDURES

### CAMBER MEASUREMENT

Check camber to determine if any components are bent or damaged. Camber angle is NOT adjustable. If angle is not to specification, components causing problem must be replaced. See ALIGNMENT SPECIFICATIONS.

### CASTER ADJUSTMENT

Check caster angle. See ALIGNMENT SPECIFICATIONS. If caster is not to specification, adjust by adding or removing shims at rear of lower control arms on all except Wrangler, or between front axle pads and spring brackets on Wrangler. See Fig. 1 or 2.

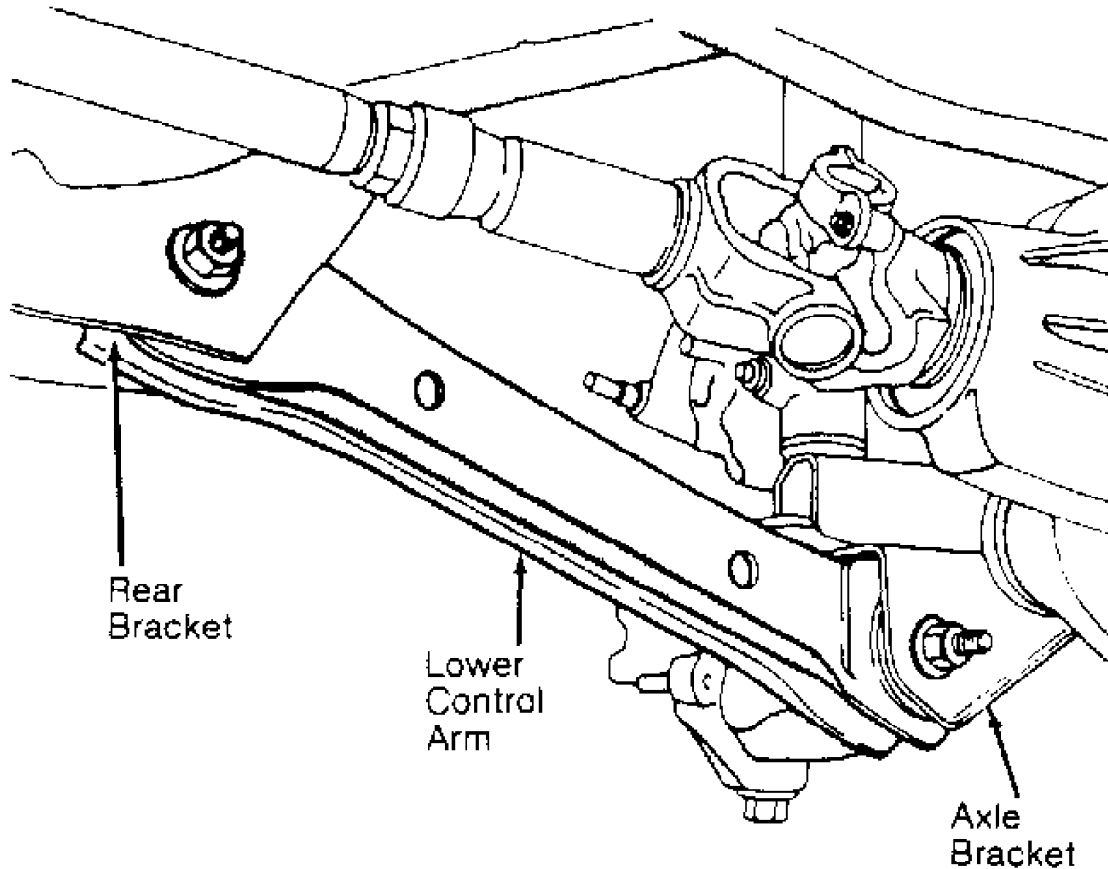


Fig. 1: Identifying Lower Control Arm (Except Wrangler)  
Courtesy of Chrysler Corp.

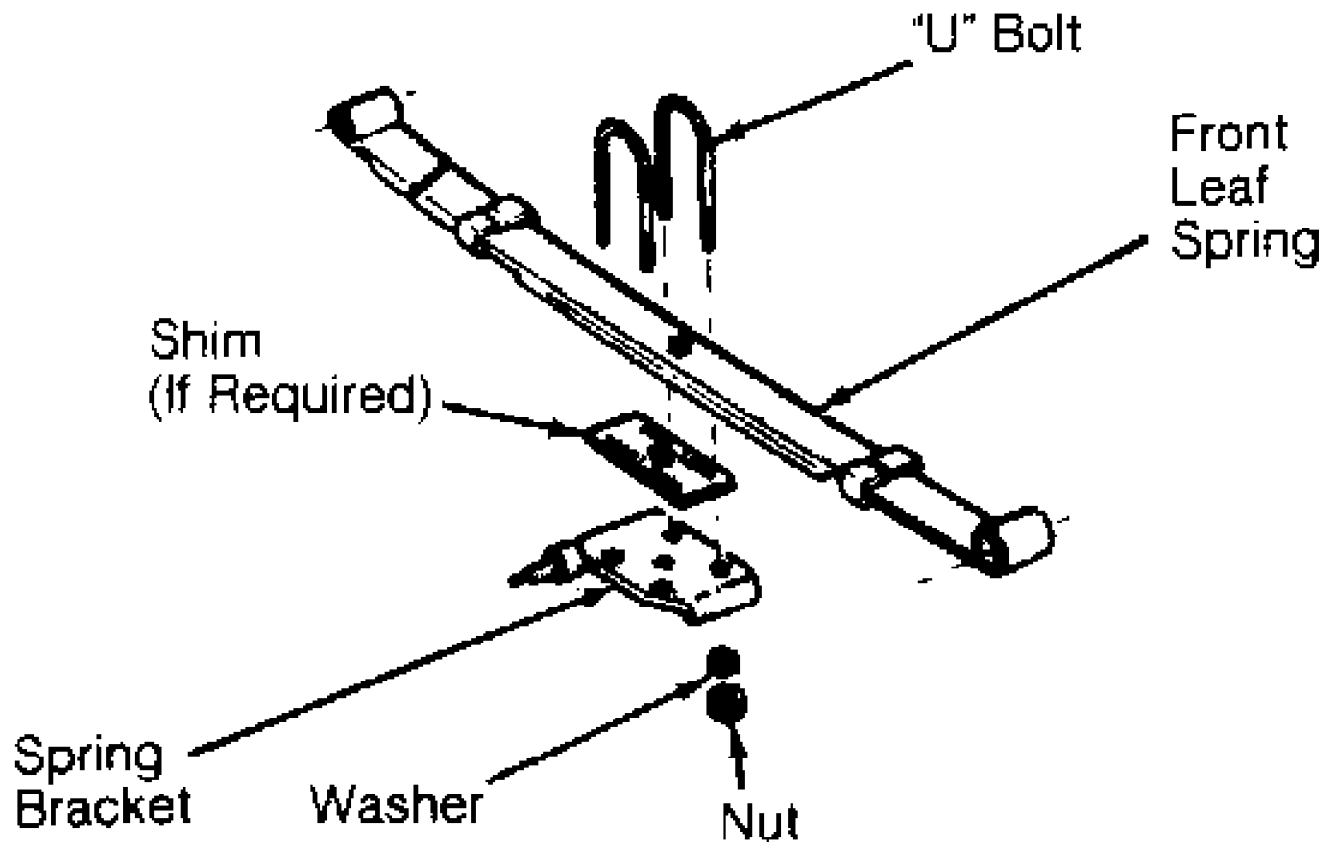


Fig. 2: Identifying Front Leaf Spring Bracket (Wrangler)  
 Courtesy of Chrysler Corp.

NOTE: On 4WD vehicles, shim adjustment will change caster angle and front drive shaft angle. If both angles cannot be adjusted to specifications, drive shaft angle has priority and should be adjusted for its specified angle. See appropriate article in DRIVE AXLES.

## TOE-IN ADJUSTMENT

Except Wrangler

1) Center front wheels straight ahead. Measure toe and compare to specifications. See ALIGNMENT SPECIFICATIONS.

2) Center steering wheel by counting the turns required to hit left and right steering stops. Center steering wheel mid-way between stops. Loosen drag link adjustment sleeve clamp bolts. See Fig. 3.

3) Rotate sleeve to adjust right wheel toe to specification. Position clamp bolts so threaded bolt ends face upward and to rear of vehicle. Tighten drag link sleeve bolts to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article.

4) Loosen clamp bolts at each end of tie rod. Rotate tie rod to adjust left wheel to toe specification. See ALIGNMENT SPECIFICATIONS. When adjustment is complete, position sleeve as described earlier and tighten to specifications. See TORQUE SPECIFICATIONS TABLE at the end of this article.

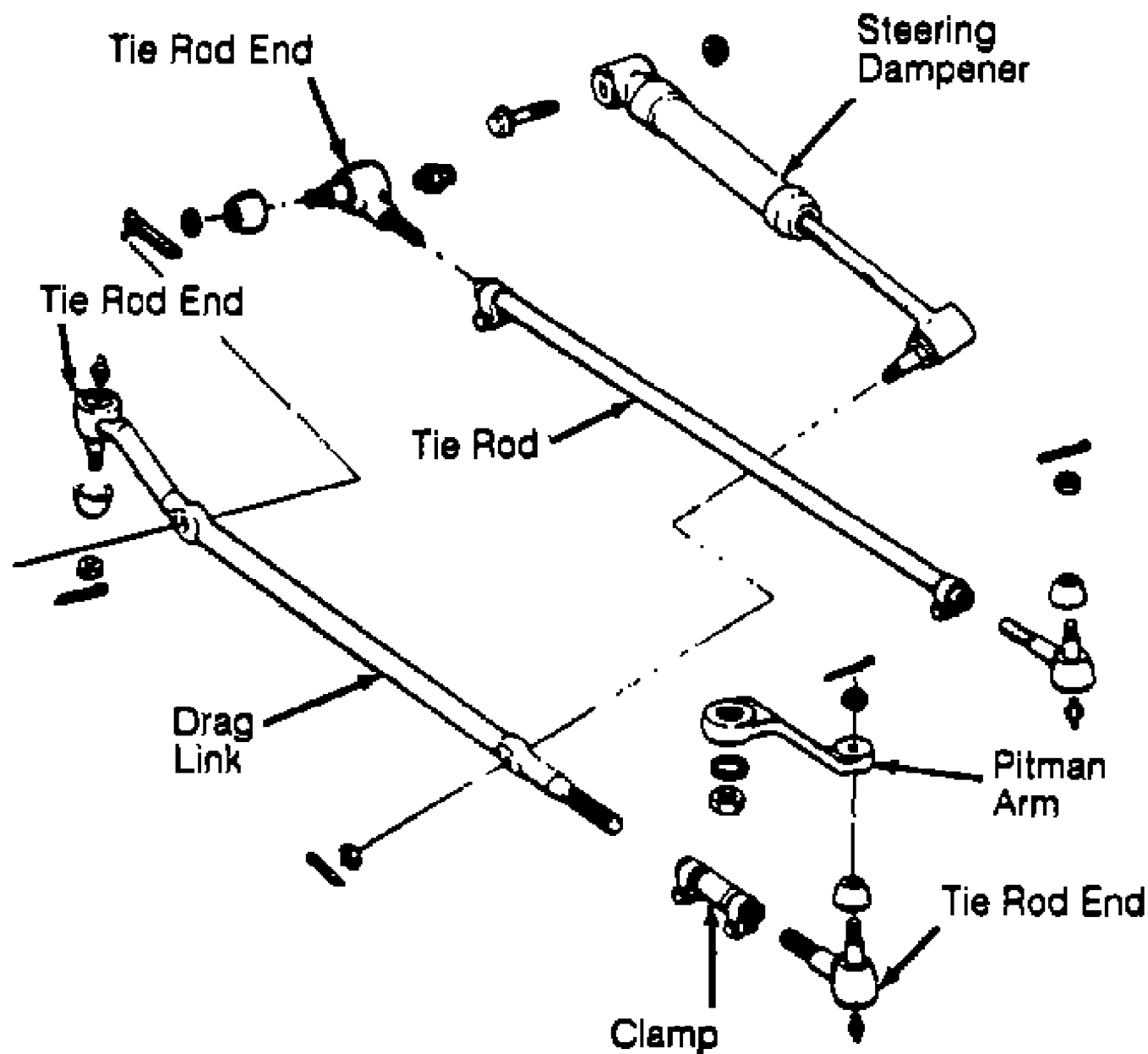


Fig. 3: Exploded View Of Steering Linkage (Except Wrangler)  
 Courtesy of Chrysler Corp.

#### Wrangler

1) Center front wheels straight ahead and lock steering wheel in centered position. Measure toe and compare to specifications. See ALIGNMENT SPECIFICATIONS.

2) Loosen tie rod adjustment sleeve clamp bolts. See Fig. 4. Rotate sleeve to adjust toe to specification. See ALIGNMENT SPECIFICATIONS. After adjustment, position clamp bolts so threaded ends face rearward and are angled upward. Tighten sleeve clamp to specification. See TORQUE SPECIFICATIONS TABLE at the end of this article.

3) If necessary, steering wheel can be centered by adjusting the drag link adjustment sleeve. When adjustment is complete, position sleeve as described earlier and tighten to specifications. See TORQUE SPECIFICATIONS TABLE at the end of this article.

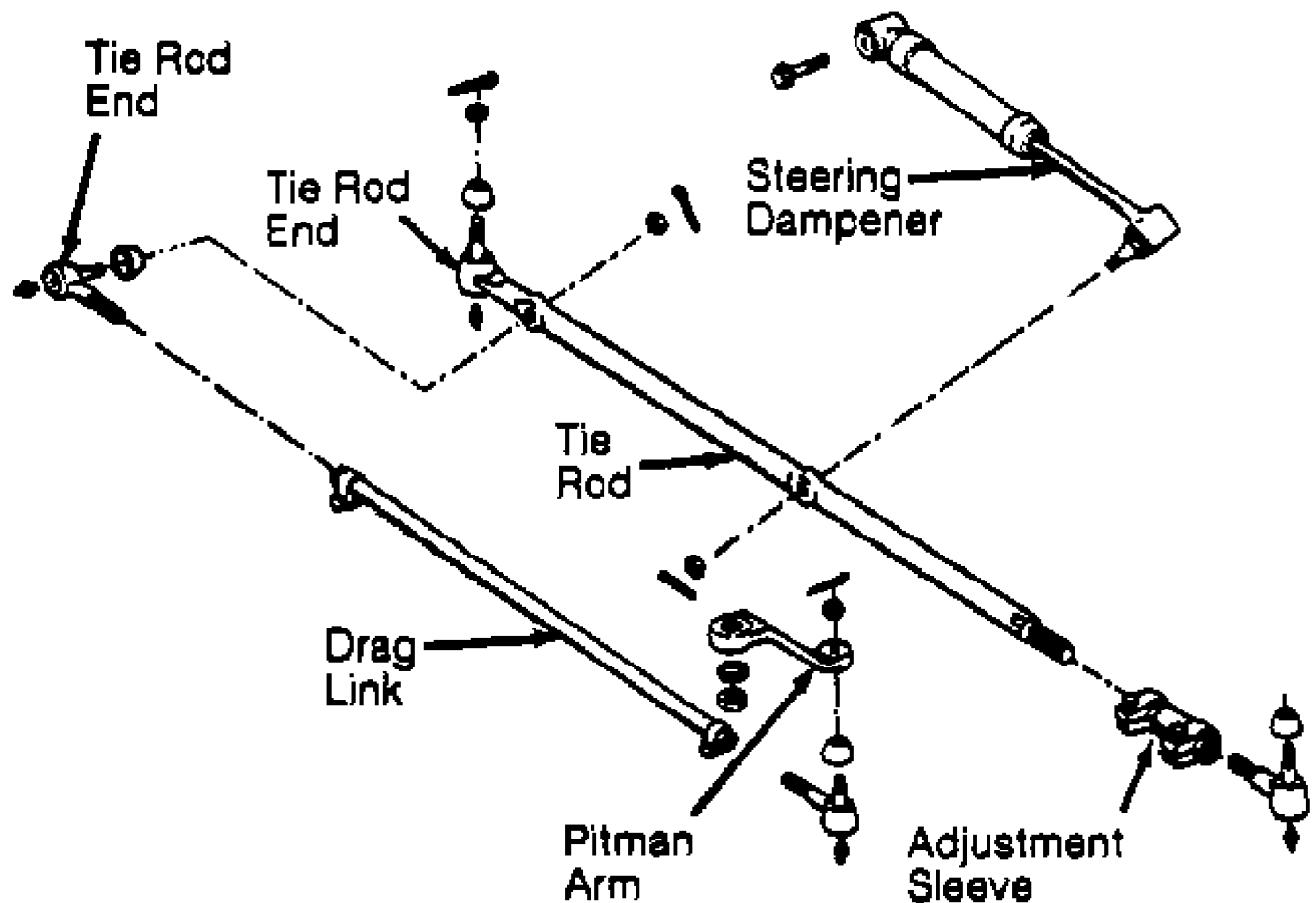


Fig. 4: Exploded View Of Steering Linkage (Wrangler)  
Courtesy of Chrysler Corp.

## ALIGNMENT SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS TABLE

Application	Preferred	Range
Cherokee		
Camber (1)	0	-.75 to .50
Caster (1)	6	5 to 7
Toe-In (1)	0	-.06 to .06
Toe-In (2)	0	-.03 to .03
Toe-Out On Turns (1)	32.5	32.5
Grand Cherokee & Grand Wagoneer		
Camber (1)	-0.25	-.75 to .50
Caster (1)	7	6.5 to 7.5
Toe-In (1)	.25	.25 to .44

Toe-In (2)	.....	.12	.....	.12 to .22
Toe-Out On Turns (1)	.....	33	.....	33
Wrangler				
Camber (1)	.....	0	.....	-0.5 to 0.5
Caster (1)	.....		.....	
Manual Transmission	.....	8	.....	6.5 to 9.0
Automatic Transmission	....	6.5	.....	5.25 to 7.25
Toe-In (1)	.....	0	.....	-.1 to .1
Toe-In (2)	.....	0	.....	-.05 to .05
Toe-Out On Turns (1)	.....	33	.....	33

(1) - Measurement in degrees.

(2) - Measurement in inches (mm).

## TORQUE SPECIFICATIONS

### TORQUE SPECIFICATIONS TABLE

Application	Ft. Lbs. (N.m)
Cherokee	
Drag Link Sleeve Clamp Bolts	36 (49)
Lower Control Arm Nuts	133 (180)
Tie Rod Sleeve Clamp Bolts	14 (19)
Wheel Lug Nut	65-90 (88-122)
Grand Cherokee & Grand Wagoneer	
Drag Link Sleeve Clamp Bolts	36 (49)
Lower Control Arm Nuts	130 (176)
Tie Rod Sleeve Clamp Bolts	25 (34)
Wheel Lug Nut	65-90 (88-122)
Wrangler	
Drag Link Sleeve Clamp Bolts	36 (49)
Spring Bracket "U" Bolt Nut	90 (122)
Tie Rod Sleeve Clamp Bolts	14 (19)
Wheel Lug Nut	65-90 (88-122)

# WIPER/WASHER SYSTEM

## 1993 Jeep Cherokee

1993 ACCESSORIES & EQUIPMENT  
Chrysler Corp. Wiper/Washer Systems

Jeep; Cherokee, Grand Cherokee, Grand Wagoneer, Wrangler

### DESCRIPTION & OPERATION

All models use a standard wiper system with a 2-speed motor and electric washers. An optional system provides an intermittent cycle. Optional rear wiper/washer system is available.

### ADJUSTMENTS

#### WIPER ARM ADJUSTMENT

Cherokee, Grand Cherokee & Grand Wagoneer

Ensure wiper shafts are in park position. Install driver-side wiper arm onto pivot shafts so that end of wiper arm is .9-2" (23-52 mm) above lower windshield reveal molding. Install passenger-side wiper arm so that its end is 1.3-2.4" (33-62 mm) above reveal molding. Blades should be parallel to lower reveal molding after installation. Install rear wiper arm (if equipped) so that midpoint of blade is .6-1.4" (15-35 mm) above lower window seal.

Wrangler

Ensure wiper shafts are in park position. Install both wiper arms onto pivot shafts so that end of wiper arms are 4 1/4-5 1/8" (108-130 mm) above lower windshield reveal molding. Blades should be parallel to each other after installation.

### TESTING

#### FRONT WIPER MOTOR TEST

Cherokee, Grand Cherokee & Grand Wagoneer

1) Measure resistance between motor connector terminal No. 4 (Black wire) and ground. Resistance should be zero ohms. If resistance is not as specified, repair open in Black wire.

2) Turn ignition switch to ACCY position. Set wiper switch in any position. Using a voltmeter, measure voltage at motor connector terminal No. 1 (Light Green/Black wire). If battery voltage exists but motor is inoperative, replace motor. If battery voltage does not exist, repair open in Light Green/Black wire. Recheck motor operation.

3) Set wiper switch in LO position. Check voltage at motor connector terminal No. 2 (Tan/Red wire). If battery voltage exists but motor is inoperative, replace motor. If battery voltage does not exist, repair open in Tan/Red wire. Recheck motor operation.

4) Set wiper switch in HI position. Check voltage at motor connector terminal No. 2 (Tan/Red wire). If battery voltage exists but motor is inoperative, replace motor. If battery voltage does not exist, repair open in Tan/Red wire. Recheck motor operation.

NOTE: On Cherokee, Brown/White wire at motor connector terminal No. 5 will change to Brown/Tan wire at splice between harness connector and motor connector.

5) Check voltage at motor connector terminal No. 5 (Brown/White wire). Turn wiper switch to OFF position while observing



voltmeter. Battery voltage should exist until wipers park. Voltage should then drop to zero volts. If voltage is as specified, but motor is inoperative, replace motor. If battery voltage is not as specified, repair open in Brown/White wire. Recheck motor operation.

#### Wrangler

1) Unplug wiper motor connector. Check for continuity between harness connector terminal "E" (Black wire) and ground. If no continuity exists, repair open circuit in Black wire to ground. Reconnect wiring to motor.

2) Turn ignition switch to accessory position. With wiper switch in any position, check for battery voltage at harness connector terminal "B" (Dark Blue wire). If battery voltage is not present, repair open circuit in Dark Blue wire from circuit breaker.

3) Set wiper switch to LO. Check for battery voltage at harness connector terminal "A" (Brown/White wire). If battery voltage is present, replace wiper motor. If battery voltage is not present, repair open circuit in Brown/White wire to wiper switch.

4) Set wiper switch to HI. Check for battery voltage at harness connector terminal "H" (Red/Yellow wire). If battery voltage is present, replace wiper motor. If battery voltage is not present, repair open circuit in Red/Yellow wire to wiper switch.

5) Check for battery voltage at harness connector terminal "D" (Dark Green/Yellow wire). Set wiper switch to OFF. Battery voltage should be present until wipers park, then drop to zero volts. If voltage is as specified, replace motor. If voltage is not as specified, repair open circuit in Dark Green/Yellow wire to wiper switch.

### FRONT WIPER SWITCH TEST

NOTE: All terminals specified in this test are on wiper switch connector for vehicles with standard wipers. For vehicles with intermittent wipers, specified terminals are on switch side connector of intermittent module. Module is on lower instrument panel cover, near steering column.

#### Cherokee & Wrangler

1) Turn ignition on. Check for battery voltage on terminal "D" (White wire). If no voltage exists, repair open circuit in White wire from circuit breaker.

2) Set wiper switch to LO. Measure voltage at terminal "E" (Gray wire). If meter does not indicate battery voltage, replace switch.

3) Set wiper switch to HI. Measure voltage at terminal "C" (Purple wire). If meter does not indicate battery voltage, replace switch.

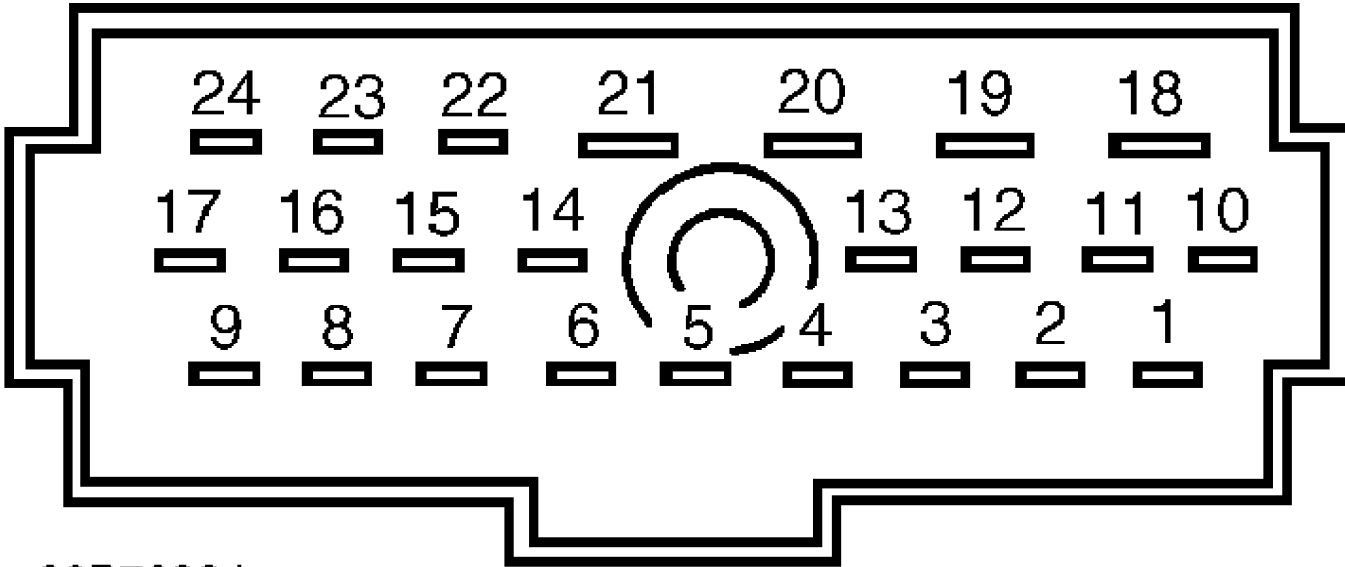
4) Measure voltage at terminal "F" (Yellow wire). Meter should indicate battery voltage. Set wiper switch to OFF. Meter should indicate battery voltage until wipers park, then drop to zero volts. If voltage is not as specified, replace switch.

5) For models with intermittent wipers, disconnect switch side connector from module. With an ohmmeter, measure resistance between terminals "A" (Dark Green wire) and "D" (White wire) while rotating switch from minimum to maximum delay. If resistance does not vary smoothly between 0-500,000 ohms, replace switch.

6) For models with intermittent wipers, disconnect switch side connector from module. With an ohmmeter, measure resistance between terminals "A" (Dark Green wire) and "G" (Brown wire) while rotating switch from minimum to maximum delay. If resistance does not vary smoothly between 0-500,000 ohms, replace switch.

#### Grand Cherokee & Grand Wagoneer

Disconnect multifunction switch harness connector. See FRONT WIPER SWITCH under REMOVAL & INSTALLATION. Using ohmmeter, check for continuity in wiper/washer terminals of multifunction switch with turned to listed wiper/washer positions. See Fig. 1. See WIPER SWITCH CONTINUITY (Grand Cherokee) table. If continuity is not as specified, multifunction switch must be replaced as an assembly.



93B76324

Fig. 1: Multifunction Switch Pin ID (Grand Cherokee & Grand Wagoneer)  
Courtesy of Chrysler Corp.

WIPER SWITCH CONTINUITY TABLE (GRAND CHEROKEE & GRAND WAGONEER)

Switch Position	Continuity Between Pins
Off	6 & 7
Delay (1) (2)	1 & 2, 1 & 4, 2 & 4, 4 & 9
Low	4 & 6
High	4 & 5
Wash	3 & 4

- (1) - Resistance at maximum delay position should be 270,000-330,000 ohms.  
(2) - Resistance at minimum delay position is zero ohms with ohmmeter set on high ohm scale.

INTERMITTENT WIPER MODULE TEST

NOTE: DO NOT move switch to intermittent mode during following test. Damage to switch rheostat will result.

- 1) Test operation of all wiper functions. If any malfunction is found, remove intermittent wiper module. Connect harness connectors together. This will remove intermittent feature from system, for test purposes. Turn ignition switch to ACCY position.
- 2) Move wiper switch through all positions EXCEPT intermittent. If wiper system functions normally, replace intermittent wiper module. Retest wiper system. If wiper system does not function properly, see FRONT WIPER MOTOR TEST and/or FRONT WIPER SWITCH TEST.

## FRONT WASHER MOTOR TEST

1) Unplug washer pump connector, under washer reservoir in engine compartment. Check for continuity between harness connector terminal "B" (Black wire) and ground. See Fig. 2. If no continuity exists, repair open circuit in Black wire to ground.

2) Connect a jumper wire between terminal "B" on washer pump and a known good ground. Using jumper wire with 15-amp in-line fuse, supply battery voltage to washer pump terminal "A" (Brown wire on Cherokee and Wrangler; Brown/Tan wire on Grand Cherokee and Grand Wagoneer). Replace pump if it does not operate.

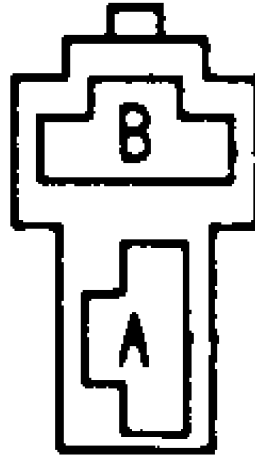


Fig. 2: Identifying Windshield Washer Pump Terminals (Typical)  
Courtesy of Chrysler Corp.

## REAR WIPER MOTOR TEST

On Cherokee, Grand Cherokee and Grand Wagoneer, disconnect wiper/washer harness at tailgate connector. On Wrangler, disconnect harness connector to lift-off top. Connect jumper wire from Black wire to good ground on motor harness connector. Using jumper wire with in-line 15-amp fuse, apply battery voltage to power feed terminal (Black/White wire on Cherokee; Brown/Light Green wire on Grand Cherokee, Grand Wagoneer and Wrangler). Wiper motor should operate.

Replace motor if inoperative.

## REAR WIPER SWITCH TEST

### Cherokee

1) Turn ignition on. Check for battery voltage at terminal "B" (Light Blue/Red wire) at rear wiper switch harness connector. If no voltage exists, repair open circuit in Light Blue/Red wire to fuse panel.

2) With rear wiper switch in any position, check for battery voltage at terminal "D" (White wire). If no voltage is indicated at terminal "D" (White wire), replace switch.

3) With switch in WASH position, check for battery voltage at terminal "C" (Brown/Red wire). Repeat test with switch in WIPE position. If no voltage is indicated in each position, replace switch.

4) With switch in WASH position, check for battery voltage at terminal "A" (Black/White wire). If no voltage is indicated, replace switch.

### Grand Cherokee & Grand Wagoneer

1) Disconnect rear wiper switch and reconnect below dash where terminals can be tested with voltmeter. See REAR WIPER SWITCH under REMOVAL & INSTALLATION. Turn ignition switch to ON position. Check for battery voltage at switch connector terminal No. 1 (Brown/Pink wire). If no voltage exists, check 30-amp fuse No. 9 in fuse box. Replace fuse, if necessary.

2) With switch in WASH position, check for battery voltage at switch connector terminal No. 4 (Black/White wire). Replace switch if battery voltage is not present.

3) With switch in ON position, check for battery voltage at switch connector terminal No. 3 (Brown/Light Green wire). Replace switch if battery voltage is not present.

4) With switch in DELAY position, check for battery voltage at switch connector terminal No. 2 (Brown/Orange wire). Replace switch if battery voltage is not present.

### Wrangler

1) Unplug harness connector at rear wiper switch. Check for continuity between terminal "C" (Black wire) at harness connector and ground. If no continuity exists, repair open circuit in Black wire to ground.

2) Turn wiper switch off. Check for continuity between terminal "B" (Brown/Light Green wire) and terminal "C" (Black wire) at switch connector. If no continuity exists, replace switch. Reconnect wiring to switch.

3) Turn ignition on. Check for battery voltage at terminal "P" (Brown/Yellow wire) at harness connector. If no voltage exists, replace fuse or repair open circuit in Brown/Yellow wire to fuse panel.

4) With switch in WASH position, check for battery voltage at terminal "B" (Brown/Light Green wire) at harness connector. Repeat test with switch in WIPER position. If no voltage exists, replace switch.

5) With switch in WASH position, check for battery voltage at terminal "A" (Brown/White wire) at harness connector. If no voltage exists, replace switch.

## REAR WASHER MOTOR TEST

1) Unplug washer pump connector, under washer reservoir in engine compartment. Check for continuity between harness connector terminal "A" (Black wire) and ground. If no continuity exists, repair open circuit in Black wire to ground.

2) Connect a jumper wire between terminal "A" on washer pump and a good ground. Supply battery voltage to washer pump terminal "B", using a jumper wire with a 15-amp in-line fuse. See Fig. 2. Pump should operate. If pump is inoperative, replace pump.

## REMOVAL & INSTALLATION

### FRONT WIPER MOTOR

Removal & Installation (Except Wrangler)

Remove wiper arms. Remove cowl trim. Disconnect washer hose. Remove cowl mounting bracket nuts and pivot pin screws. Disconnect wiring. Remove wiper motor. To install, reverse removal procedure. Adjust wiper blades. See WIPER ARM ADJUSTMENT under ADJUSTMENTS.

Removal & Installation (Wrangler)

1) Remove top, if installed. Remove windshield hold-down bolts from lower corners of instrument panel. Remove wiper motor mounting screws. Disconnect wiper linkage drive arm. Remove wiper motor wire harness retaining clip. Pull motor and drive arm out through access hole.

2) Pry drive arm from motor pivot. DO NOT remove pivot attaching nut. Remove intermittent module bracket screws. Reach behind instrument panel to disconnect wiper motor harness. Remove wiper motor. To install, reverse removal procedure. Adjust wiper blades. See WIPER ARM ADJUSTMENT under ADJUSTMENTS.

### FRONT WIPER SWITCH

Removal (Cherokee & Wrangler)

1) Disconnect negative battery cable. For vehicles with optional steering wheel, push and turn horn button to remove it. Remove retaining screws, bushing, receiver, flexplate and insulator. On all models, remove 3 retaining screws and steering wheel cover.

2) Disconnect horn wiring. Remove grounding pin by pulling it out gently. Remove steering wheel retaining nut and vibration damper. Mark steering shaft and steering wheel for reassembly reference. Using steering wheel puller, remove steering wheel.

CAUTION: Lock plate is retained by a high pressure spring. DO NOT remove snap ring without using a compressor tool.

3) Remove lock plate cover. Compress lock plate with Lock Plate Compressor (C-4156). Remove lock plate retaining ring, lock plate, canceling cam and spring. On vehicles with optional steering wheel, remove horn button components from canceling cam. Discard lock plate retaining ring.

4) Remove hazard warning switch knob, dimmer switch actuating arm screw and turn signal switch attaching screws. On Cherokee, remove lower instrument panel trim panel. On Wrangler, remove steering column shroud screws. Slide shroud toward steering wheel. On all models, apply pressure upward to shroud and downward to instrument panel to free holding tabs.

5) Remove cover under steering column. Remove PRNDL clip (if equipped). Remove 2 nuts and 4 bolts from steering column bracket. Loosen steering column brace nut at kick panel. Ease steering column downward.

6) Unplug wiper switch connector. Tape wires to wiper connector to ease harness removal. Remove wiring harness cover from column. Pull turn signal switch out from column far enough for access to retaining screws.

7) Turn ignition switch on. Insert paper clip below key

warning buzzer retainer to flatten retainer. Remove key warning buzzer and retaining clip as an assembly. DO NOT try to remove warning buzzer and retaining clip separately; clip could fall into column jacket.

8) Remove ignition lock cylinder retaining screw and lock cylinder. Remove attaching screws, housing and shroud. Ensure dimmer switch rod, lock pin and lock rack do not fall out. Remove turn signal/wiper switch lever from housing. Remove wiper switch cover from rear of housing. Remove pivot screw and wiper switch.

#### Installation (Cherokee & Wrangler)

1) Install NEW switch. Push dimmer switch rod to ensure it is connected. Position housing to column. Ensure nylon spring retainer is forward of lock rack retaining slot. Position first tooth of gear so that it engages with first tooth of lock rack.

2) Install housing attaching screws and key lock cylinder. Carefully tighten screws while mating housing to column. Turn key to ensure lock pin extends fully when ignition switch is locked.

3) To complete installation, reverse removal procedure. Install NEW lock plate retaining ring. Ensure wires are flat against inside column. Ensure PRNDL cable clip is installed so that pointer aligns properly. Reinstall steering wheel and tighten nut to 25 ft. lbs. (34 N.m).

#### Removal & Installation (Grand Cherokee & Grand Wagoneer)

1) Disconnect negative battery cable. Remove tilt lever (if equipped). Remove upper and lower steering column trim covers. Remove knee blocker. Remove steering column mounting nuts.

2) Lower steering column to gain access to rear of multifunction switch. Using Remover (TTXR20B2), remove tamper-proof mounting screws. Gently pull multifunction switch away from steering column. Loosen connector screw sufficiently to remove connector. Screw will remain in connector. Remove connector. To install, reverse removal procedure. Install NEW tamper-proof switch mounting screws. Tighten multifunction switch mounting screws to 17 INCH lbs. (2 N.m).

### FRONT WASHER MOTOR

#### Removal & Installation

Remove reservoir mounting screws and reservoir. Disconnect hose from pump. Drain reservoir. Remove filter nuts from inside reservoir. Remove washer pump motor. To install, reverse removal procedure.

### REAR WIPER MOTOR

#### Removal & Installation (Except Wrangler)

Remove wiper arm. Slide clip along hose to remove it from hose mounting. Disconnect hose. Remove pivot pin retaining nut. Remove liftgate trim panel. Disconnect wiring harness. Remove hinge nut securing motor to top. Remove wiper motor. To install, reverse removal procedure.

#### Removal & Installation (Wrangler)

Remove wiper arm. Remove pivot shaft retaining nut and trim cover. Unplug electrical connector. Remove mounting screws and wiper motor. To install, reverse removal procedure.

### REAR WIPER SWITCH

#### Removal & Installation (Cherokee)

Disconnect negative battery cable. Remove 4 instrument bezel retaining screws. Pull bezel away from snap attachments. Remove switch housing panel. Unplug switch connector. Press mounting tabs and remove

switch. To install, reverse removal procedure.

#### Removal & Installation (Grand Cherokee & Grand Wagoneer)

1) Disconnect negative battery cable. Remove ash tray. Remove screws securing center cluster bezel. Remove cluster center bezel. Remove dash pad retaining screws behind top of center bezel. Gently pry defroster grille out of dash pad. Unplug sensors from grille (if equipped). Set defroster grille aside.

2) Remove screws holding defroster duct, instrument cluster and glove box to dash pad. Pulling up and out to unsnap end clips, remove dash pad. With driver's door open, remove left side trim cover, steering column cover and knee bolster. Remove steering column retaining nuts.

3) Remove screws securing bottom of end bezel and switch pod bezel. Remove screws retaining top of end bezel and switch pod bezel. Remove end bezel. Starting on the left side, remove remaining switch pod bezel retaining screws. Pull switch pod bezel out sufficiently to disconnect switch connectors.

4) Disconnect switch connectors. Remove switch pod bezel. Remove switch retaining screws. Remove switch. To install, reverse removal procedure.

#### Removal & Installation (Wrangler)

Disconnect negative battery cable. Remove 6 instrument panel shroud screws. Slide shroud toward steering wheel. Pull bulb socket from bulb retainer. Press shroud upward and indicator panel downward to release holding tabs. Place shroud under steering column. Remove switch housing panel. Press switch mounting tabs and remove switch. To install, reverse removal procedure.

### REAR WASHER MOTOR

#### Removal & Installation

Rear washer pump is located next to front washer pump. See FRONT WASHER MOTOR.

### WIRING DIAGRAMS

See appropriate chassis wiring diagram in WIRING DIAGRAMS.

# WIRING DIAGRAMS

## 1993 Jeep Cherokee

1993 WIRING DIAGRAMS  
Jeep Wiring Diagrams

Jeep; Cherokee

### IDENTIFICATION

### COMPONENT LOCATION MENU

#### COMPONENT LOCATIONS TABLE

Component	Location (Fig. No.)
A/C COMP CLUTCH RELAY .....	B 19 (5)
A/C HEATER LT .....	B 11 (3)
A/C MODE SELECT SW .....	A 16-17 (5)
A/C THERMOSTAT .....	B 19 (5)
ABS MAIN RELAY .....	C 15 (4)
ABS PUMP/MOTOR RELAY .....	A 15 (4)
ALTERNATOR .....	E 3 (1)
ANTI-LOCK BRAKE .....	A-D 12 (4)
ANTI-THEFT .....	(11 & 12)
ASHTRAY LT .....	B 11 (3)
AUTO SHUTDOWN RELAY .....	A 7 (2)
BACK-UP LT SW .....	B 16 (5)
BALLAST RESISTOR RELAY .....	C 7 (2)
BATTERY .....	A 2 (1)
BEAM SELECT SW .....	D-E 23 (6)
BLOWER MOTOR .....	A 19 (5)
BRAKE WARN SW .....	A 8 (3)
CARGO LT .....	A 34 (9)
CCD DATA LINK CONN .....	D 19 (5)
CHIME MODULE .....	B 8 (3)
CIG LTR .....	C 11 (3)
CIG LTR LT .....	C 11 (3)
COOLING FAN RELAY .....	B 16 (5)
COURTESY LTS .....	A 33 (9)
CRUISE CONTROL SERVO .....	A 20 (6)
CRUISE CONTROL SW .....	A-B 20 (6)
DEFOG SW LT .....	B 11 (3)
DEFOG SYSTEM .....	E 34-35 (9)
DIR FLASHER .....	C 9 (3)
DIR/HAZARD SW .....	C-D 19 (5)
DOME/READING LT .....	A 32 (9)
DOOR LOCKS SWS .....	B-C 26 (7)
DOOR SWS .....	A 35 (9)
ECE CONN .....	E 19 (5)
ENGINE DIAG CONN .....	D 7 (2)
FOG LT RELAY .....	E 2 (1)
FOG LT SW .....	A 27 (7)
FRONT AXLE LOCK-UP SW .....	D 27 (7)
FRONT WASHER MOTOR .....	D 22 (6)
FUEL PUMP RELAY .....	B 7 (2)
FUEL TANK UNIT .....	B 7 (2)
FUSE BLOCK .....	C-E 9-10 (3)
GEAR SELECT SW .....	C 16 (5)
GLOVE BOX LT .....	A 34 (9)
HAZARD FLASHER .....	E 10 (3)

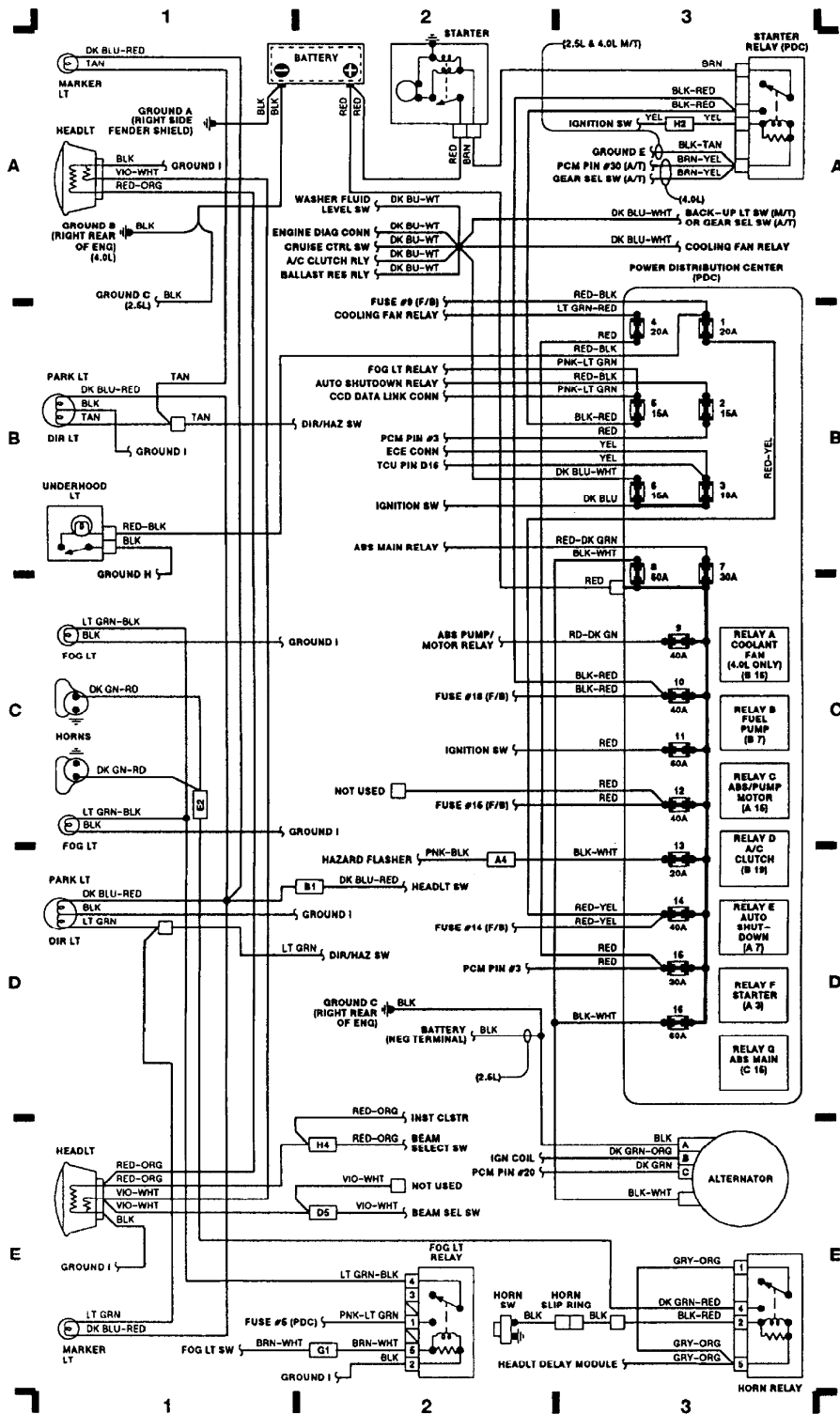


HEADLT DELAY MODULE	E 23	(7)
HEADLT SW	B-D 23	(6)
HEATER MODE SELECT SW	A 18	(5)
HORN RELAY	E 3	(1)
IGNITION COIL	D 7	(2)
IGNITION SW	A 8-11	(3)
ILLUM LTS	B-C 11	(3)
INSTRUMENT CLUSTER	A-C 24-27	(7)
KEY IN SW	C 19	(5)
KEYLESS ENTRY MODULE	A 31	(8)
LCD ILLUM RELAY	B 23	(6)
LEFT FRONT DOOR SW	B 35	(9)
LIFTGATE LT SW	A 35	(9)
LOCK RELAY	B 31	(8)
PARK BRAKE SW	A 8	(3)
POWER DISTRIBUTION CENTER (PDC)	B-D 3	(1)
POWER DOOR LOCK SYSTEM	A-B 28-31	(8)
POWER MIRRORS	D-E 32-34	(9)
POWER SEAT	B-D 32-33	(9)
POWER WINDOWS	E 31	(8)
REAR WASHER MOTOR	B 35	(9)
REAR WIPER LT	B 11	(3)
REAR WIPER/WASHER	B-C 33-35	(9)
SEAT BELT SW	B 8	(3)
STARTER	A 2	(1)
STARTER RELAY	A 3	(1)
STOP LT RELAY	E 36	(10)
STOP LT SW	A 23	(6)
TRAILER CONN	A 36	(10)
TRAILER TOW IN-LINE CB	E 37	(10)
TRANS CONTROL UNOT (TCU)	D-E 16	(5)
TRANSFER CASE LT	B 11	(3)
TRANSMISSION	E 17-16	(5)
TRANSMISSION RANGE RW LT	B 11	(3)
UNDERHOOD LT	B 1	(1)
VANITY LTS	A 32-33	(9)
W/SHIELD WIPER SW	C-E 20	(6)
WARNING INDICATORS	D 24-27	(7)
WASHER FLUID LEVEL SW	C-D 27	(7)
WIPER CIRCUIT BREAKER	C 9	(3)
WIPER MOTOR	D 22	(6)

#### GROUND LOCATIONS TABLE

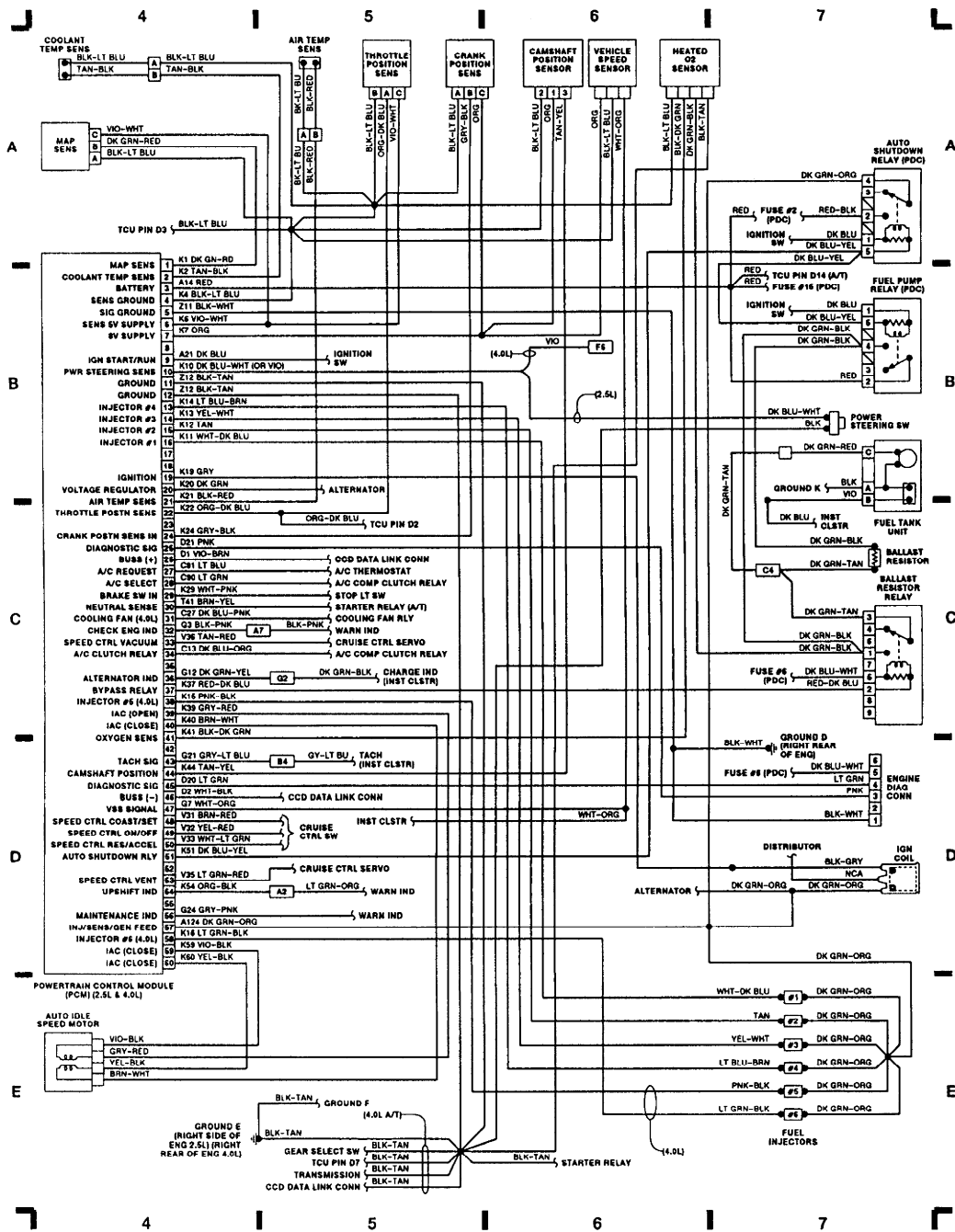
Component	Location (Fig. No.)
GROUND A: (RIGHT SIDE FENDER SHIELD)	A 1 (1)
GROUND B: (RIGHT REAR OF ENGINE 4.0L)	A 1 (1)
GROUND C: (RIGHT REAR OF ENGINE)	D 2 (1)
GROUND D: (RIGHT REAR OF ENGINE)	D 7 (2)
GROUND E: (RIGHT SIDE OF ENGINE 2.5L)	E 4 (2)
(RIGHT REAR OF ENGINE 4.0L)	E 4 (2)
GROUND F: (LEFT SIDE SHIELD)	A 15 (4)
GROUND G: (LEFT SIDE COWL)	A-B 13 (4)
GROUND H: (RIGHT SIDE SHIELD)	B 22 (6)
GROUND I: (LEFT SIDE SHIELD)	E 24 (7)
GROUND J: (RIGHT SIDE KICK PANEL)	E 26 (7)
GROUND K: (LEFT SIDE COVER)	E 39 (10)

## WIRING DIAGRAMS

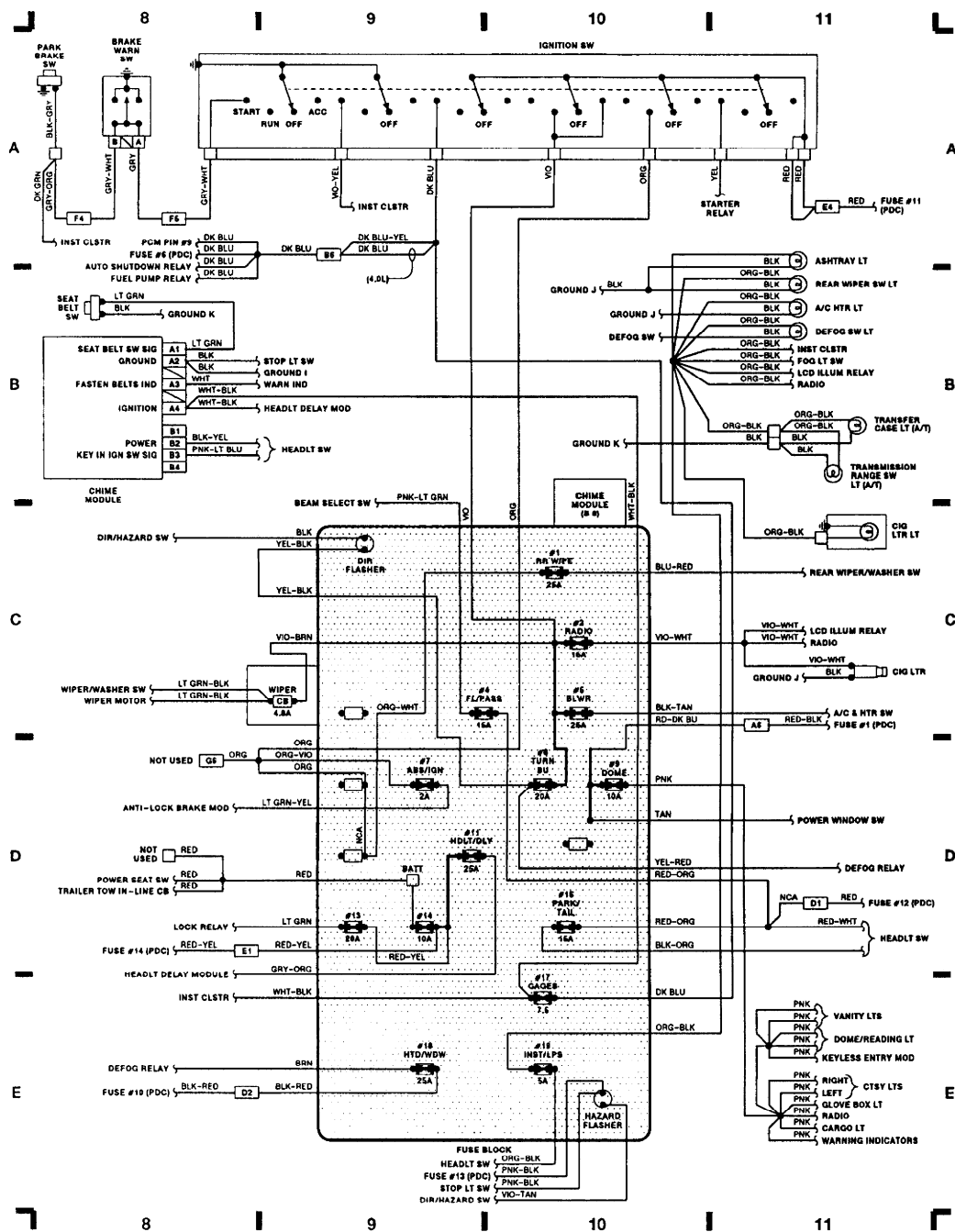


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Fig. 1: Engine Compartment & Headlights (Grids 1-3)

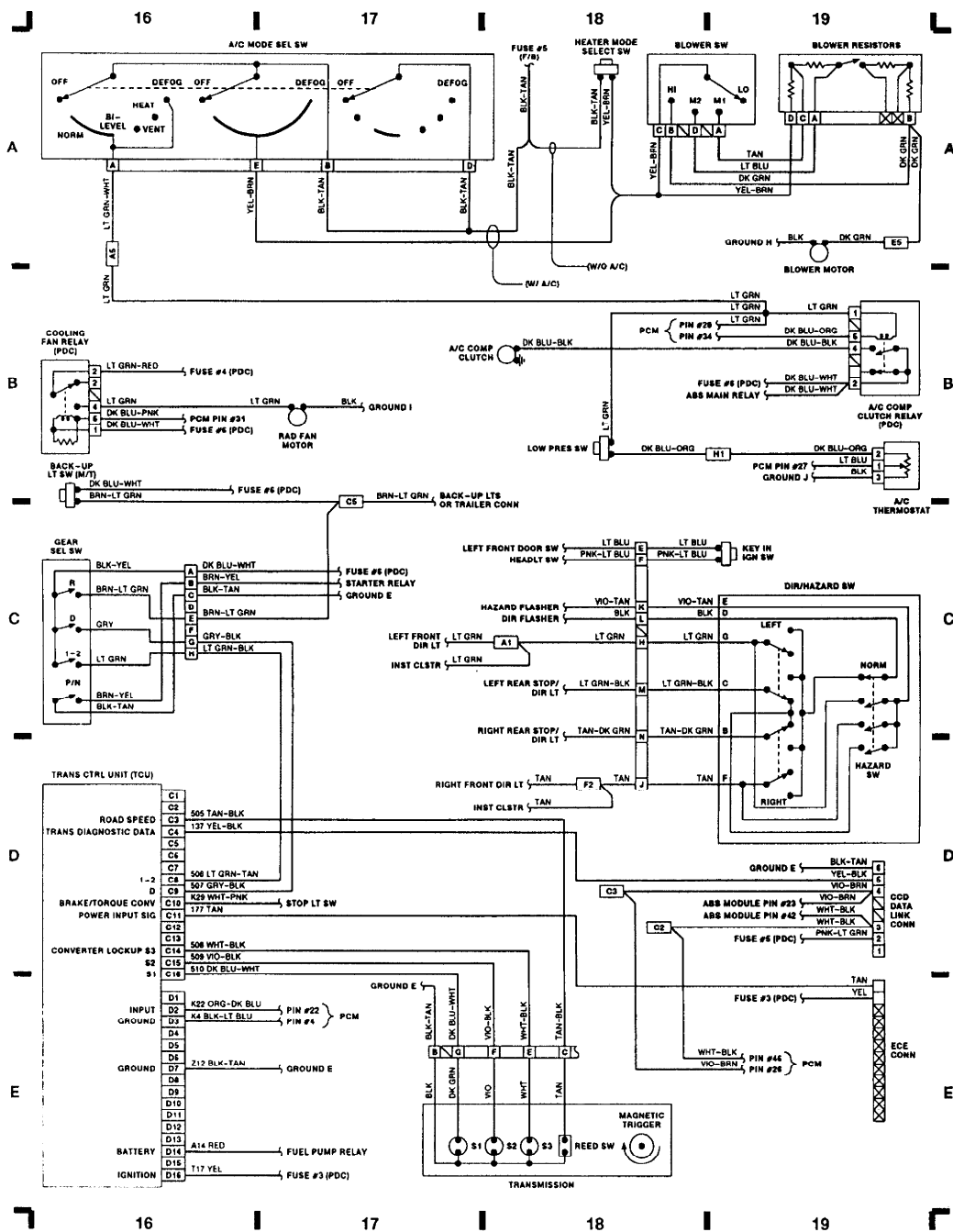


93F77839  
Fig. 2: Powertrain Control Module (PCM) (2.5L & 4.0L) (Grids 4-7)



93177840  
Fig. 3: Ignition Switch (Grids 8-11)





93A77842  
Fig. 5: Dir/Hazard Switch, Trans Control Unit (TCU) (Grids 16-19)

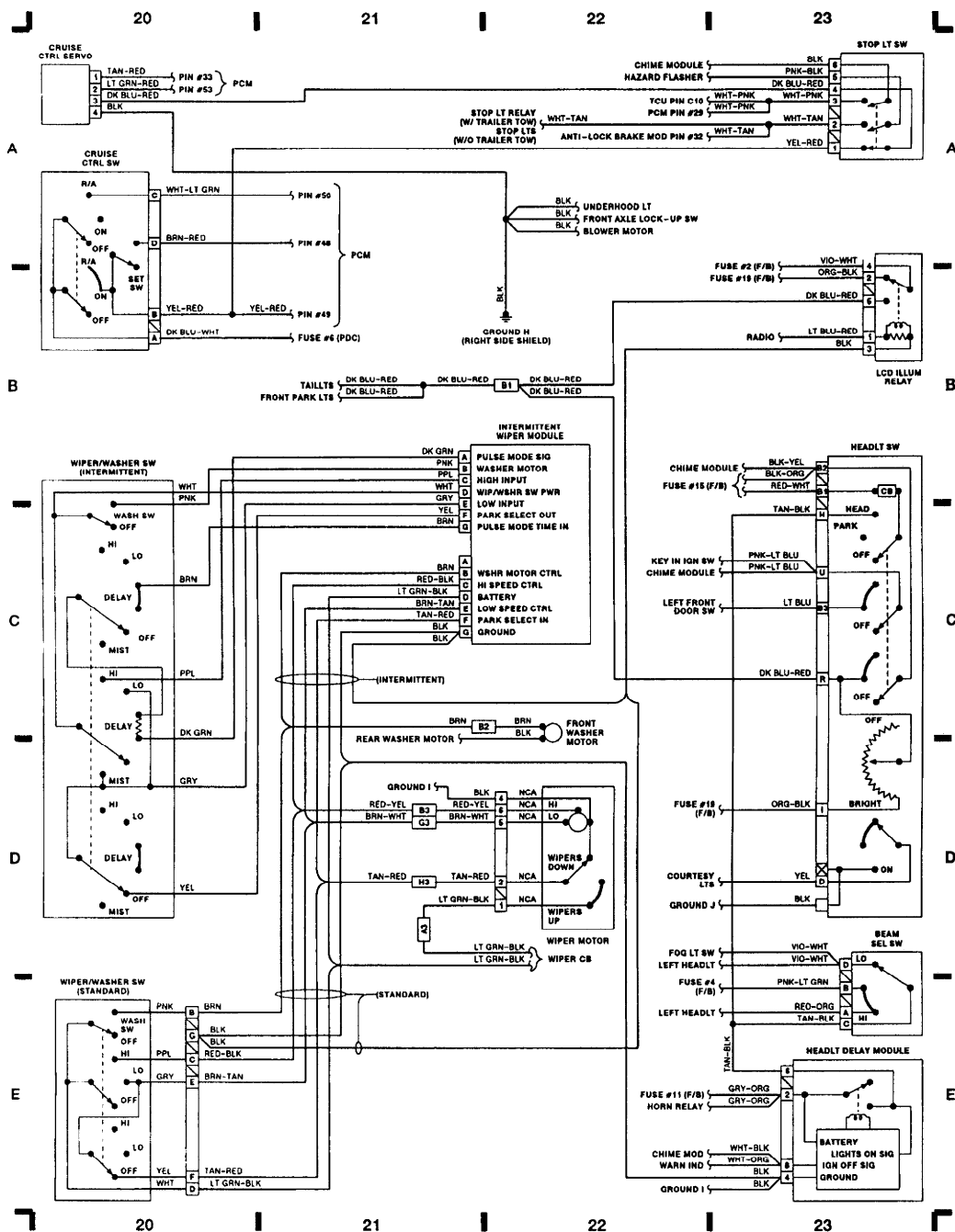
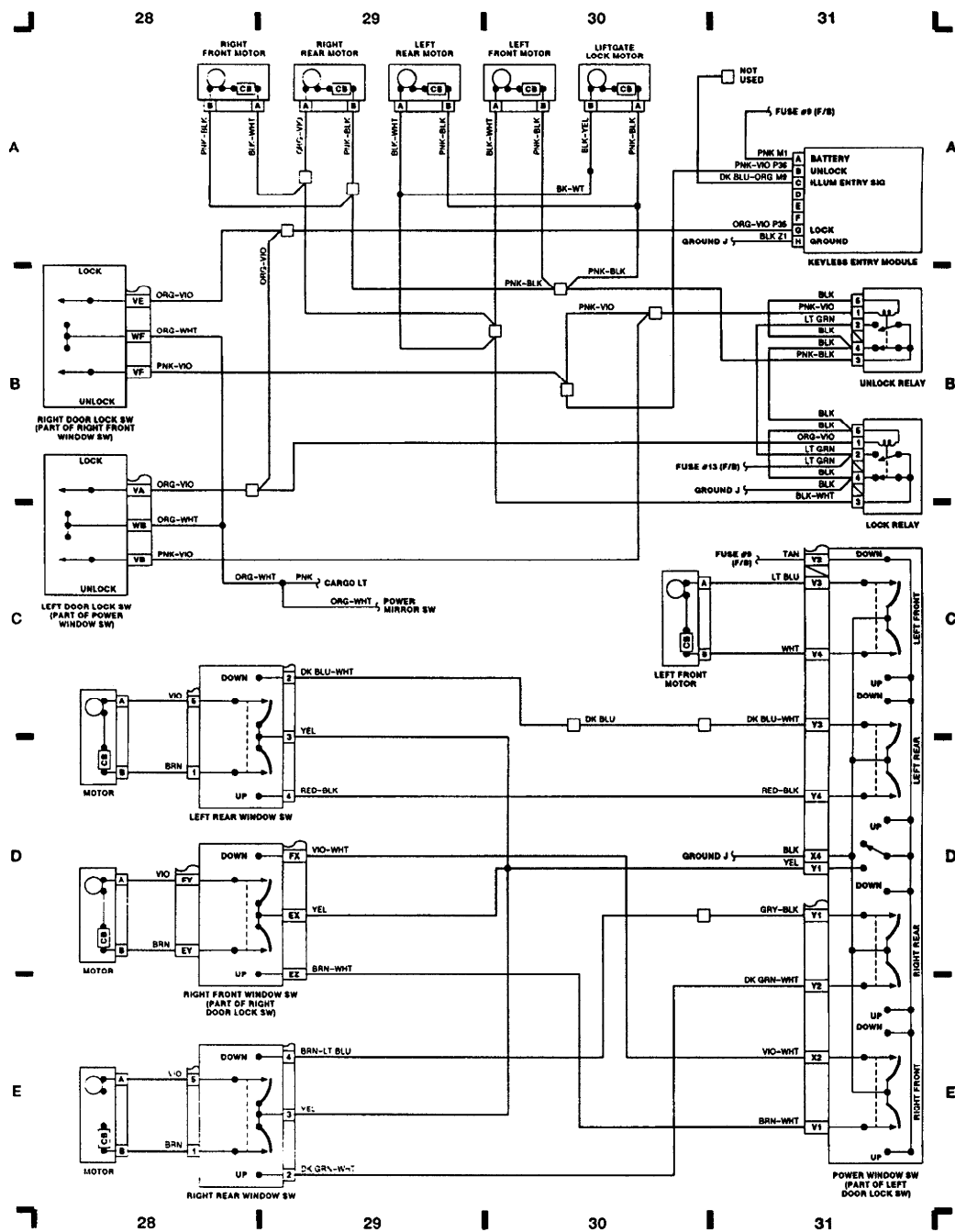


Fig. 6: Wiper/Washer Switches, Stop Light Switch (Grids 20-23)



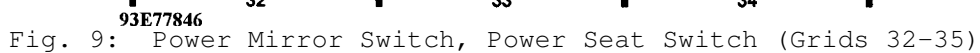
Fig. 7: Instrument Cluster (High Line), (Low Line) (Grids 24-27)





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Fig. 8: Power Window Switch, Right and Left Door Switch (Grids 28-31)



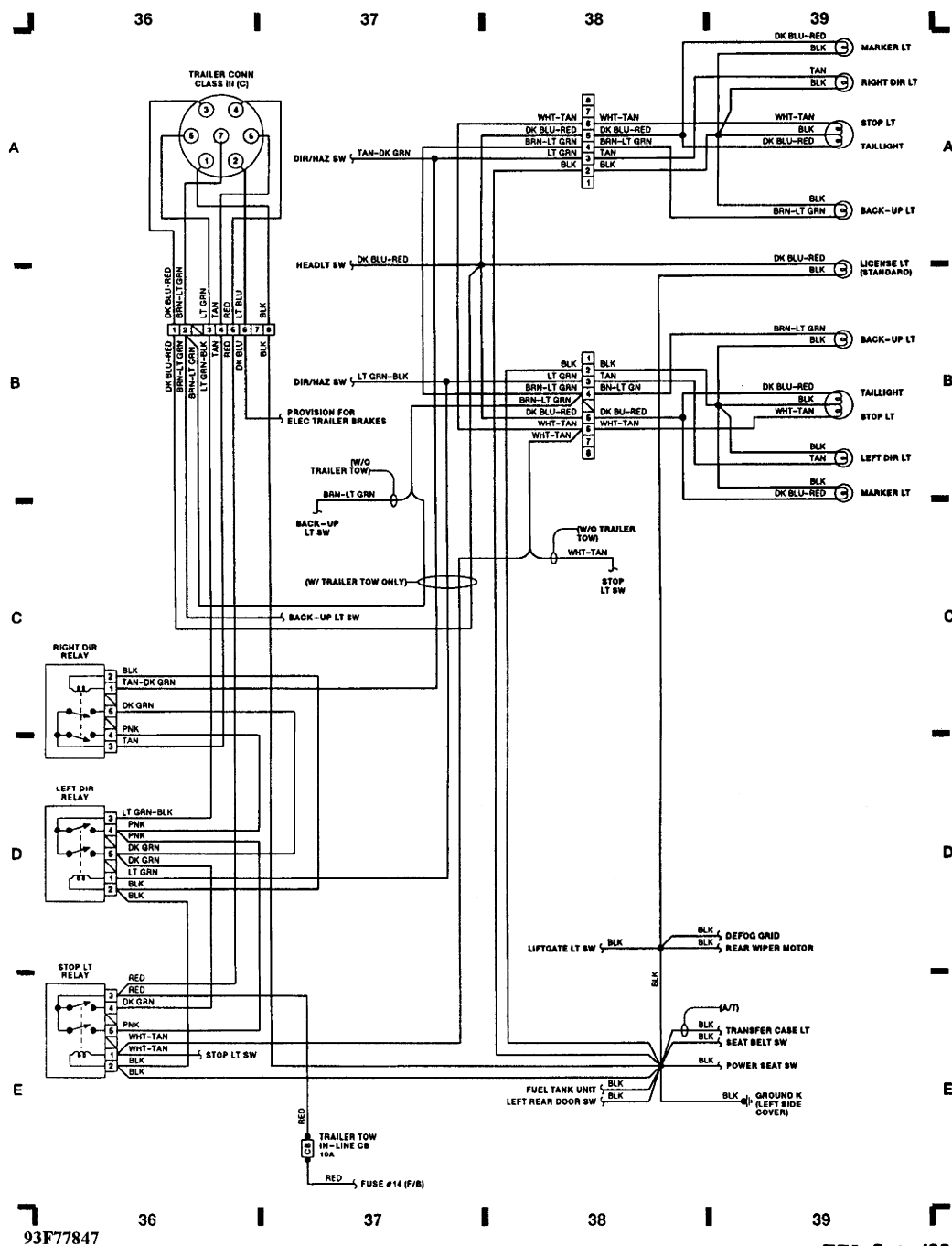
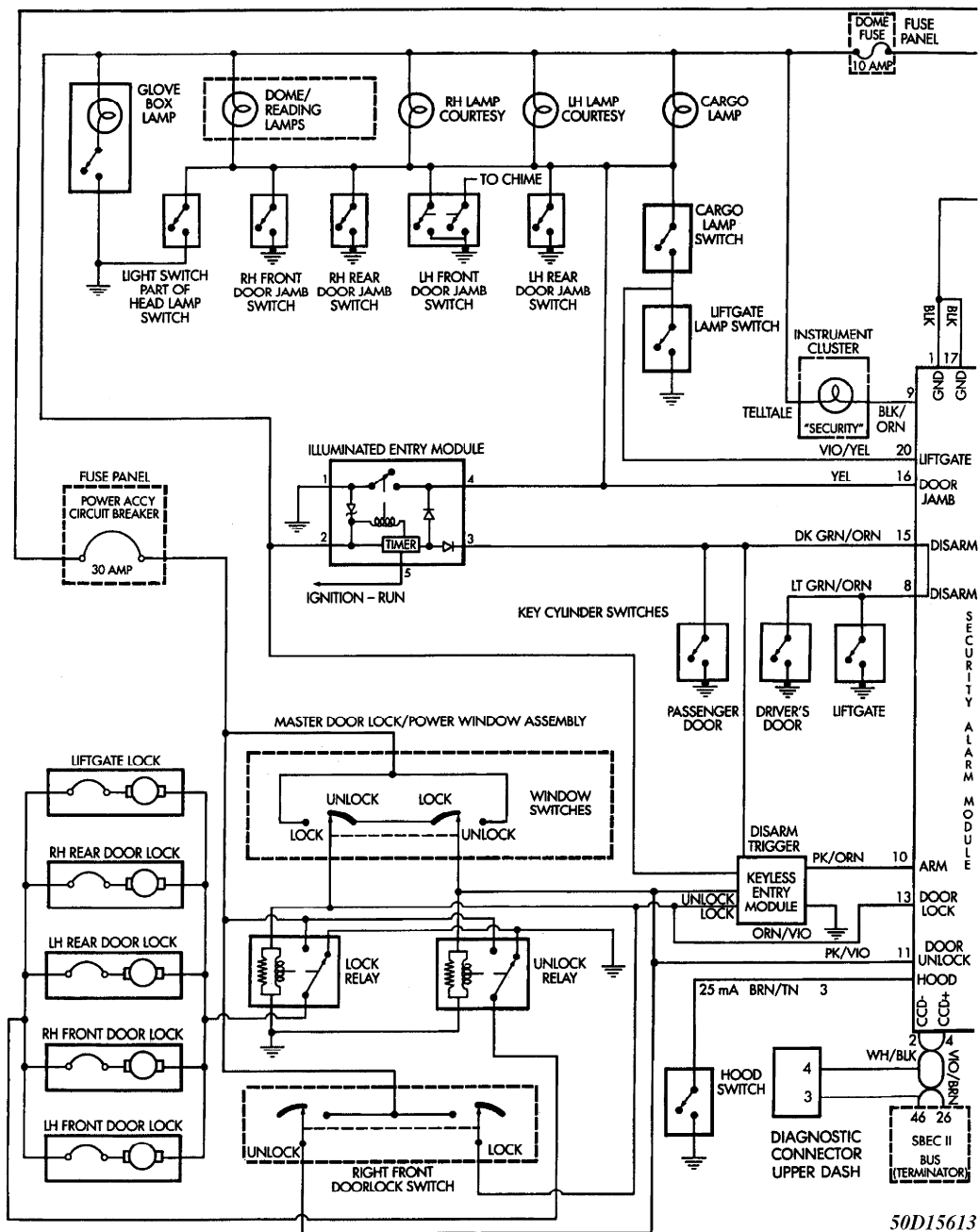


Fig. 10: Power Mirror, Window Switches & Taillights (Grids 36-39)



50D15613

Fig. 11: Anti-Theft System (1 of 2)

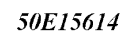


Fig. 12: Anti-Theft System (2 of 2)

# WIRING DIAGRAM SYMBOLS

## 1993 Jeep Cherokee

WIRING DIAGRAMS  
How To Use The Wiring Diagrams

### WIRING DIAGRAMS

#### INTRODUCTION

The wiring diagrams and technical service bulletins, containing wiring diagram changes, are obtained from the domestic and import manufacturers. These are checked for accuracy and are all redrawn into a consistent format for easy use.

All diagrams are arranged with the front of the vehicle at the left side of the first page and the rear of the vehicle at the right side of the last page. Accessories are shown near the end of the diagram.

Components are shown in their approximate location on the vehicle. Due to the constantly increasing number of components on vehicles today, it is impossible to show exact locations.

In the past, when cars were simpler, diagrams were simpler. All components were connected by wires, and diagrams seldom exceeded 4 pages in length. Today some wiring diagrams require more than 16 pages. It would be impractical to expect a service technician to trace a wire from page 1 across every page to page 16.

Removing some of the wiring maze reduces eyestrain and time wasted searching across several pages. Today, the majority of diagrams now follow a much improved format, which permits space for internal switch details and connector shapes.

Any wires that don't connect directly to their components are identified on the diagram to indicate where they go. There is a legend on the first page of each diagram, detailing component location. It refers you to sub-systems, using grid NUMBERS at the top and bottom of the page and grid LETTERS on each side. This grid system works in a manner similar to that of a road map.

#### HOW TO USE THE WIRING DIAGRAMS

1) On the first page of the diagram, you will find a listing of major electrical components or systems. Locate the specific component or system you wish to trace. A grid number and letter will follow the component's name.

2) Use the grid NUMBERS (arranged horizontally across the top and bottom of each page) to find the page of the wiring diagram that contains the component you're seeking. When you reach this page, use the grid LETTERS on the side of the page to determine the component's vertical location.

3) Locate the circuit you need to service. The internals are shown for switches and relays to assist you in understanding how the circuit operates.

NOTE: In some of the newer wiring diagram articles in this product, there is a Legend for the wiring diagrams that has been created to make locating components easier. For these articles, there will be a COMPONENT LOCATION MENU title in the article main menu. These articles will also have the original legend available on the first graphic.

① } **TEMP SENS  
(GND)**

② } **BATTERY (+)**

③ } **FUEL GAUGE  
(INST CLSTR)**

---

Fig. 1: Identifying Tie-Off Symbols

4) If the wires are not drawn all the way to another component (across several pages), a reference will tell you their final destination.

5) Again, use the legend on the first page of the wiring diagram to determine the grid number and letter of the referenced component. You can then turn directly to it without tracing wires across several pages.

6) The symbols shown in Fig. 1 are called tie-offs. The first tie-off shown indicates that the circuit goes to the temperature sensor, and is also a ground circuit.

7) The second symbol indicates that the circuit goes to a battery positive parallel circuit. The third symbol leads to a particular component and the location is also given.

8) The lines shown in Fig. 2 are called options. Which path or option to take depends on what engine or systems the vehicle has.

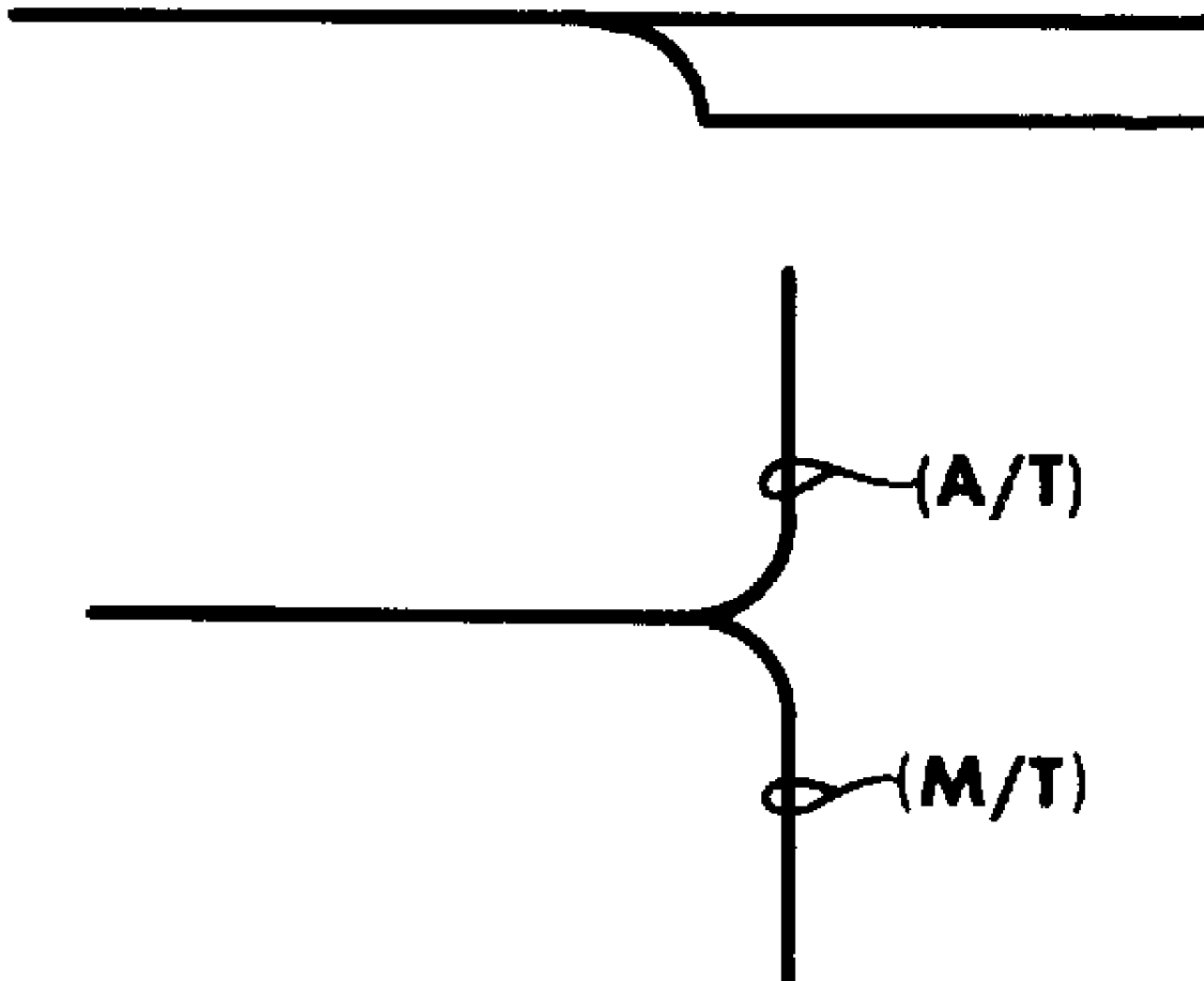


Fig. 2: Identifying Option Symbols

## COLOR ABBREVIATIONS IDENTIFICATION

### COLOR ABBREVIATIONS

Color	Normal	Optional
Black .....	BLK .....	BK
Blue .....	BLU .....	BU
Brown .....	BRN .....	BN
Clear .....	CLR .....	CR
Dark Blue .....	DK BLU .....	DK BU
Dark Green .....	DK GRN .....	DK GN
Green .....	GRN .....	GN
Gray .....	GRY .....	GY
Light Blue .....	LT BLU .....	LT BU
Light Green .....	LT GRN .....	LT GN
Orange .....	ORG .....	OG
Pink .....	PNK .....	PK
Purple .....	PPL .....	PL
Red .....	RED .....	RD
Tan .....	TAN .....	TN



Voilet	.....	VIO	.....	VI
White	.....	WHT	.....	WT
Yellow	.....	YEL	.....	YL

WIRING DIAGRAM SYMBOL IDENTIFICATION

NOTE: Standard wiring symbols are used on diagrams. The list below will help clarify any symbols that are not easily understood at a glance. Most components are labeled "Motor", "Switch" or "Relay" in addition to being drawn with the standard symbol.

WIRING DIAGRAM SYMBOLS

Views of the symbols used in the WIRING DIAGRAM articles are in the following graphics. See Figs. 3 through 25.



CIRCUIT BREAKER

Fig. 3: Circuit Breaker



COIL (Internal)

Fig. 4: Coil (Internal)



CONNECTOR

Fig. 5: Connector

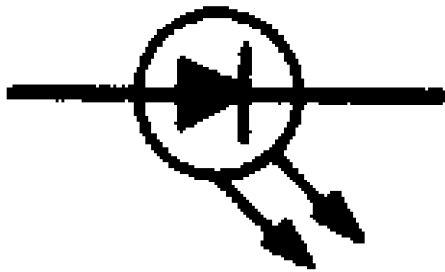


DIODE (In-Line)

Fig. 6: Diode (In-Line)



Fig. 7: Diode (Internal)



**DIODE (Light Emitting)**

Fig. 8: Diode (Light Emitting)



**DEFOGGER GRID**

Fig. 9: Defogger Grid



**FUSE**

Fig. 10: Fuse



**FUSIBLE LINK**

Fig. 11: Fusible Link



**GROUND**

Fig. 12: Ground



**GLOW PLUG, RESISTOR (In-Line)  
MIRROR HEATER**

Fig. 13: Glow Plug Resistor (In-Line) or Mirror Heater



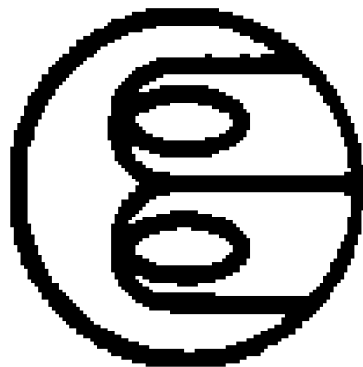
**INJECTOR, PHOTOCELL**

Fig. 14: Injector (Diesel) or Photocell (Gasoline)



**INTERNAL FUSE,  
THERMAL LIMITER**

Fig. 15: Internal Fuse, Thermal Limiter



**LAMP (Dual Element)**

Fig. 16: Lamp (Dual Element)



**LAMP (Single Element)**

Fig. 17: Lamp (Single Element)



**MOTOR**

Fig. 18: Motor



**RESISTOR (Internal)**

Fig. 19: Resistor (Internal)



**SENSOR, THERMISTOR**

Fig. 20: Sensor, Thermistor

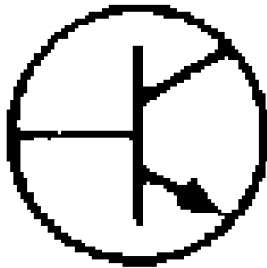
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**SOLENOID**

Fig. 21: Solenoid

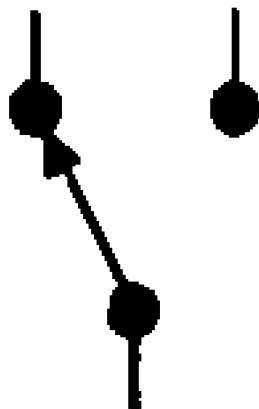
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**SOLID STATE DEVICE,  
TRANSISTOR**

Fig. 22: Solid State Device, Transistor

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**SWITCH (Internal)**

Fig. 23: Switch (Internal)



**TWO PIN SWITCH**

Fig. 24: Two Pin Switch



**VARIABLE RESISTOR  
OR POTENTIOMETER**

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Fig. 25: Variable Resistor or Potentiometer